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LESTER F. EASTWOOD, JR.
JERRY FOSHAGE
GUILLERMO GOMEZ
BECKY KIRKPATRICK
BARRY KONIG
BRET SMITH
ROBERT STEIN
FRANCIS VITHAYATHIL
KATHERINE WARNER

CENTER FOR DEVELOPMENT TECHNOLOGY
BOX 1106
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI 63130

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CENTER FOR DEVELOPMENT TECHNOLOGY
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI
63130

PROGRAM ON
STIMULATING OPERATIONAL PRIVATE SECTOR USE OF EARTH OBSERVATION SATELLITE DATA

BY

LESTER F. EASTWOOD, JR.
JERRY FOSHAGE
GUILLERMO GOMEZ
BECKY KIRKPATRICK
BARRY KONIG
BRET SMITH
ROBERT STEIN
FRANCIS VITHAYATHIL
KATHERINE WARNER

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16. Abstract

This report reviews progress on the project on Stimulating the Operational Private Sector Use of Earth Observation Satellite Information for the period January 15, 1980 through June 15, 1980. Primary effort in this period centered on developing and refining ideas for new businesses specializing in using remote sensing and computerized spatial data systems. Each such organization serves a specialized application as an "information middleman," buying raw satellite or aircraft imagery, processing these data, combining them in a computer system with customer-specific information, and marketing the resulting information products. Applications studied include agribusiness, forestry, mining, real estate, urban planning and redevelopment, and consumer information. The best of these ideas for new business will form the basis for experiments, designed by this project and carried out by NASA, to assess their commercial feasibility.

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INTRODUCTION
(Executive Summary)

This report reviews progress on the project on "Stimulating the Operational Private Sector Use of Earth Observation Satellite Information" for the period January through June 15, 1980. Primary effort centered on developing promising ideas for new businesses specializing in natural resources and socioeconomic information management systems (remote sensing and spatial data information systems).

Our project's primary goal is to assist NASA in planning ASVT's to test the feasibility of new modes of private sector involvement in remote sensing and computerized geographic information system (CGIS) technology. Each ASVT is to demonstrate and assess a model private sector organization. Each organization will serve a specialized application as an "information middleman," buying raw satellite data and aircraft imagery, processing these data, combining them in a CGIS with customer-specific data from other sources to put together specialized information packages, and marketing these products to private or public sector customers. Each ASVT's purpose will be to test the marketplace viability of its model business. If successful, its results will be publicized to inspire entrepreneurs to copy the idea.

Our research group comes to this project with extensive experience in determining the information needs of potential users of remote sensing; translating these needs into feasible information product designs; and identifying the skills, equipment, and money needed to produce these products. In our Earth Observation Data Management System (EODMS) project, we accomplished these tasks for over fifty state agencies in five

Midwestern states, developing an extensive data base and foundation of experience that we are applying to the current project.

The primary relevant EODMS finding is that raw remote sensing data requires extensive processing, and combination in a CGIS with data from other sources, if it is to realize its full potential value. This processing requires skills and resources unavailable to most potential users. Needed is a way to bridge the gap between raw remote sensing data and the maps, tables, and reports from which most of society gets its information. In those areas in which demand is sufficient, the profit motive can stimulate bridging this gap, motivating technology transfer. This opportunity inspires our project.

Our work has progressed along a number of fronts. First, we have created ideas for new businesses serving industry (forestry, agribusiness, mining, real estate, and transportation); local, regional, and state government (e.g. planning and redevelopment agencies); and the consumer (advising in homebuying, food purchasing, and travel). These ideas resulted from staff brainstorming and literature review, surveys of firms already in the remote sensing business, and recommendations from experts. The survey of the current "information middleman" industry, using letter and telephone contacts with more than 100 firms, has determined where much of the current market activity takes place. This survey has identified attractive markets for further study, while at the same time steering us away from duplicating services already offered commercially.

We have also made progress in evaluating the new business ideas. While some of our ideas remain in the first concept stage, others (e.g. agribusiness, urban information systems, and consumer information) are already undergoing intensive evaluation. This evaluation is assessing

potential customers' information sources to determine how they could serve customer needs better if augmented with remote sensing or CGIS-based information. In the urban and consumer product areas, we are developing sample information products to display to potential customers to enhance this assessment. We have begun surveys of customers in these areas and in forestry to determine information needs. In agribusiness, we have consulted with experts to assess our ideas for information products. We have also laid the groundwork for an intensive cost and profitability analysis in this area.

Another satisfying bit of progress, initially unexpected, has been the amount of publicity the project has received. Three articles in various campus publications alerted the general press to the project, resulting in interviews with a St. Louis Post Dispatch feature writer and a United Press International representative. The Post recently published a headline feature in its widely-read "Everyday" section, while the UPI article has appeared nationally. Recently, Business Week magazine has contacted the University, expressing interest in the project. This report includes copies of the published articles as Appendix A.

The project is generally on schedule, although it did not begin until it was funded in mid-January 1980, despite a contract date of November, 1979. This loss of time initially may require an extension to allow us to put in the full year's effort planned in our proposal.

The body of this report reviews progress in our industry survey and in each application area study. In addition, we offer some preliminary conclusions and in the final section, describe plans for further work. Appendices present details of some of the analyses, copies of key project correspondence, and reproductions of newspaper coverage of the project.

REPORT OF PROGRESS UNDER NASA CONTRACT NUMBERED NASW-3331 January-June, 1980

This report summarizes progress made in the first six months of work on the above-referenced contract.* It reports progress on the four activities indicated in the statement of work:

1) Define information service areas.
2) Develop information product specifications.
3) Analyze market/opportunities.
4) Design ASVT project.

For ease of reference in this first progress report, our proposal's description of each activity appears below. The statement of work dictates that we follow this plan. The progress reports later in this section relate to these activities.

The program of research is an important step in planning new NASA technology transfer initiatives to stimulate private sector involvement in remote sensing. Ideally, the successful ASVT's will demonstrate small model businesses that entrepreneurs throughout the country could emulate. Successful ASVT's will prove not only technical but commercial feasibility, eliminating some risk and startup development cost and freeing up venture capital.

This ASVT planning study is taking the following steps:

---

*The contract effective date was November 1, 1979, to include a relevant conference. However, with the exception of attendance at this conference, research on the contract did not begin until January, 1980, after the funds had been received at Washington University.

Activity A: Develop a List of Feasible ASVT Candidates

1. Develop preliminary ideas for "model business" ASVT's. Generate these ideas by: brainstorming; reviewing the literature; interviewing or surveying interested entrepreneurs; and reviewing recent recommendations from formal sources. Examples of such sources are current ASVT reports, the National Council of State Legislatures, the summary of the recent tech transfer industrial advisory committee meeting, and Office of Science and Technology Policy reports.

2. Check to see that each ASVT idea is a new operational application. That is, review previous ASVT's and other operational/quasi-operational applications of remote sensing to verify that the idea breaks new ground. In particular, verify that it does not duplicate existing private sector activity.

3. Demonstrate by review of the literature on remote sensing applications and experiments that the ideas are technically feasible.

Activity B: Identify the ASVT Ideas That Are Most Likely to Be Commercially Successful

1. Review information needs in each ASVT's application area. Use surveys and in-depth interviews with potential customers, literature on remote-sensing based information products, and consultation with experts to identify and characterize the potential market information needs.

2. Design information packages -- the products of the "model businesses" -- to serve these information needs.

3. Survey potential customers' willingness to pay for these products. Make preliminary estimates of rates, costs, and potential profitability.

4. Where possible, make cost vs. income and return-on-investment estimates to demonstrate the potential for financial viability of a business producing these information products.

Activity C: Produce A Final Report Recommending The Most Attractive ASVT Ideas for Implementation

1. Present at least three recommended ASVT designs, including details of product design and potential customers' needs and options.

2. Justify the recommendations. List all ideas generated in Part A. Show how the recommended ASVT's compare to the others in terms of their potential for financial success.

3. Display the estimated financial statements.

To date, we have accomplished much of Activity A, and we are progressing well in Activity B. That is, we have developed an initial set of ASVT candidates, and we are closely scrutinizing some of those that appear most attractive. The following list summarizes the particular tasks ongoing in these activity areas:

1. *Review the structure and activities of current private suppliers of earth resource satellite or CGIS-based information.*

2. *Investigate unfilled user needs, delineate target market characteristics (including willingness to pay and appropriate format for information provision) and conduct a profitability, sensitivity, and risk analysis on a proposed ASVT in agribusiness.*

3. *Assess the private sector's potential to develop and market urban information systems.*

4. *Design new or modify existing businesses to provide consumers with CGIS or remote sensing-based information in areas such as travel and home or commodity purchase.*

5. *Propose commercial applications for expanded uses of remote sensing and CGIS's in forestry.*

6. *Survey geological/mining industry uses and investigate avenues for further commercial development.*

Task 1 supports Activity A as described in the proposal. Activity A also resulted in the choices of agribusiness, urban information, consumer information, forestry, and mining as areas of concentration for the Activity B analysis occurring in Tasks 2-6.

The remainder of this section describes in detail our progress in the six tasks. We begin with a summary of results from our brief industry survey.

Task 1: Survey of Current Suppliers

Knowledge of what is being done in the "information middleman" industry, in particular, of how current industries are structured, what services they offer, and to whom, is basic in planning new business activity. It establishes a check system to eliminate ideas currently being used, and market areas currently being served. The survey also helps define the present user market: who the users are, what their needs are, what types of information products they buy, and their willingness to pay for these products.

Our survey was a brief one, because NASA has funded and is funding other contractors to do detailed surveys of the remote sensing business. Therefore we sought information not included in current surveys. Moreover, to limit the time spent, we did not attempt to be complete, preferring instead simply to get a feel for the broad variety of activities in the current market.

As a first step in the survey, we studied other market surveys, published or ongoing, both for guidance and to avoid duplication. Ned Buchman, Remote Sensing Coordinator, Public Technology, Inc. informed us that he is developing a Remote Sensing Procurement Package for State and Local government to help these governments to utilize private sector remote sensing companies. In addition, Metrics Inc. conducted a survey in 1975 of remote sensing users (suppliers) to determine their present and future interests in remote sensing. The results were published in their U.S. Remote Sensing Market Survey (1976/76) and updated later in International Remote Sensing Activities (1977/78). Currently Metrics is doing a LANDSAT Remote Sensing Market Forecast (1979/80), about which

Mr. G. William Spann has kept us informed. Moreover, Staff Scientist George Wukelic of Battelle Labs in Washington sent us a copy of "Sources for LANDSAT Assistance and Services." It was most useful in helping us find the appropriate companies to investigate. Finally, the California Environmental Data Center has kept us up to date on activities of its industrial advisory committee.

These sources and others (e.g. conference mailing lists) enabled us to to put together a mailing list of more than 100 companies. The list and a copy of an initial survey letter appears in Appendix B. We received a fair amount of response to the letter, and we followed up with telephone interviews of companies selected for their diversified use of LANDSAT, other remotely sensed data, and CGIS's. All companies that we followed up offer not solely hardware, but also information products and services. A copy of one telephone interview form, filled out for Ecographics International Environmental Analysis, appears in Appendix B.

As the interview form shows, the information we acquired from the telephone interviews was detailed. The following text attempts a brief summary of highlights for firms particularly relevant to our project goals. It discusses methodologies, company structure, examples of past projects, products and services, and future plans. One caveat: these descriptions may contain inaccuracies, due to the limited resources we could devote to the survey. Moreover, some of the statements are our opinions, and should be read as such. The conclusion of this section summarizes the survey results and lists issues that need further study.

1. Earth Satellite Corporation is a large company with a multidisciplinary staff including engineers, scientists, economists, and market

specialists. Uniquely, all persons in EARTHSAT projects have knowledge of remote sensing techniques. In contrast, other companies have remote sensing experts while other disciplines within the company have little or no knowledge of remote sensing techniques. While the majority of EARTHSAT's customers are relatively large, EARTHSAT is investigating ways to involve the "smaller" user. Ninety-five percent of their customers repeatedly buy EARTHSAT's information products. EARTHSAT is always evaluating and implementing new remote sensing techniques while being one of the few suppliers that design their own in-house hardware. Because of the availability of EARTHSAT's facilities for customer use, training in advanced exploration techniques is provided for those clients requesting it. EARTHSAT undertakes projects involving most of the application areas listed on the sample interview form in Appendix B.

2. *Ebasco Services Incorporated* is a consulting organization which serves primarily the utility industry. Their work in remote sensing entails supervising the acquisition and the interpretation of imagery. Applications include siting studies for nuclear, fossil fueled, and hydro-projects; and exploring for base metals, coal, and uranium. Siting studies require an in-depth analysis; thus, remote sensing is only one of many tools used for these studies. Generally, fifty man-years of ground truth collection is needed to satisfy the many requirements of the Nuclear Regulatory Commission. Five thousand employees within Ebasco serve to meet these needs.

3. *Burke and Associates (Environmental Division)* utilizes remote sensing data for environmental applications. Their primary capabilities lie in the areas of researching, assessing, planning, inventorying, and

mapping of environmental concerns. They have used remote sensing in the following applications: environmental evaluation of coastal projects; ecological surveys; environmental assessments; and protection and planning recommendations for: highways, bridges, channels and canals, marinas, and pumping stations; impact of pipeline canals; and delineation of growth conservation boundaries. Burke and Associates employs about one hundred people, blending natural and social scientists with eight to twenty physical scientists (depending upon the size of projects undertaken simultaneously).

4. *Dames and Moore* is a consulting agency that uses remote sensing to support and fill in gaps in existing data bases. LANDSAT is used early in the investigation process to identify potential "problem" areas which need more detailed investigation by lower altitude imagery and/or field work. Their energy-related applications are siting studies for nuclear and fossil fueled power plants, transmission line corridors, oil and gas processing, manufacturing and storage facilities, and solid waste disposal facilities. Remote sensing is a "tool" used for these projects as demonstrated in transmission line corridor sitings. Dames and Moore will provide accessibility information and existing natural and land use conditions along proposed routes, which can extend over hundreds of line miles.*

5. *Comarc Design Systems* specializes in and is oriented toward selling their computerized geographical information systems. They have

*"The Role of Remote Sensing in Practiced Geotechnical and Environmental Applications - A Consultant's Approach," A. D. Becassio, A. E. Redfield, Dames and Moore, Washington, D.C.

developed a resource management and inventory system with applications in forestry, environmental planning, urban planning, oil and gas resources, and water resource management utilizing hardware and software packages which are conversational and easily operated. In addition, customers have access to Comarc's own computers. Such a system, for example, has helped plan increased food production and economic growth in Indonesia. The geobased system is most useful in keeping track of rapidly expanding urban areas. Lower altitude imagery is used, but ground truth findings are the most useful source of data for their CGIS's.

6. *Ecographics International Environmental Analysis* is a supplier specializing in ecological applications. They have done various range studies mostly in the Far Western United States, but not exclusively, and they are just beginning to do some mineral exploration. Most important is the fact that, unlike other suppliers, Ecographics' International targets the "small" user who has less money to spend or less frequency of need. Two major problems have been encountered by Ecographics in soliciting the "smaller" user.

1) unawareness of remote sensing applications that can be beneficial to them, and

2) intimidation by the "large" supplier in terms of costs of products and services.

Ecographics is attempting to solve these problems, and has begun holding workshops in San Diego which aim to educate the "small" user of the potential uses of remote sensing and geobased data to fill their own needs. When a potential user asks Ecographics for assistance, Ecographics will propose a project and define the user's needs at no cost. Resolving

the problem of costs can only be done by the supplier's keeping low operating costs, thus reducing costs passed on to the customer. This is done in a few important ways. Ecographics International has no in-house computer system. They time-share at a private university with other companies. Also, they only have a staff of about three to five full-time experts. They will put together a temporary team, consisting of professional consultants depending on the application area, for each project undertaken. If multiple projects are within one application area, the team can undertake more than one project. The result is a lower full-time payroll.

7. *Environmental Research and Technology Incorporated* is a research oriented corporation comprised of a milti-disciplinary staff of eight hundred employees, with six specializing in remote sensing. ERTI's investigation into the use of LANDSAT and other remotely sensed data for the detection of sea and ice cover to help with the location of offshore building platforms for oil drilling, is one of the first of its kind. Other application areas being researched are identification of wildlife habitat, reclamation planning of coal mines, range management, plant sitings, pipeline and transmission line corridor studies, and land use studies. Because of ERTI's priorities towards research, they receive all CCT's and other remotely sensed data at no cost from the U.S. government. Remote sensing is solely used as a service and is only part of an analysis done by ERTI. They also do some manual photo interpretation.

8. *Earth Resources Data Analysis Systems, Inc.* specializes in land management and resource analysis. They have created geographical data

bases which they constantly update. They use these data bases to analyze optimal locations for camps and parks, land management of agricultural and forestry concerns, and wildlife habitat studies. They have been able to sell the CGIS's including hardware and software to a variety of federal government agencies. The system can be a mini or micro system, is conversational, and therefore operable by almost anyone with some computer background.

9. Geospectra Corporation is a geologically oriented company supplying products and services mostly to the oil and mining industry. Geospectra has a small staff and the bulk of the work is done by one person. This is contradictory to the fact that most suppliers have specialists in each discipline and may give rise to differences in the analytical techniques used by Geospectra. Remotely sensed data is their most important data source followed by topographic and seismographic data. Geospectra leases software packages to those with the expertise and hardware for proper usage.

10. Lockheed Corporation has recently established the Remote Sensing Application Laboratory (RSAL). RSAL acquires, processes, and analyzes the data to develop useful products. The RSAL will also use assistance by management, scientific, and engineering experts in defining user information requirements and providing tools for decision making. Lockheed has over four hundred experts available for consultation on applications in environmental monitoring, land use mapping, urban anal/sis, forestry and agriculture assessment, system studies, and software development and training.

11. *T.R.W. Inc.* is a research oriented company. They designed the EROS Digital Image Processing System (EDIPs). TRW targets a large user with a goal of selling a complete hardware/software system. They are very selective about who their customers are, and always lean towards an application in which a development of technology is needed to optimize the analysis. The application areas TRW has pursued are environmental impacts, land use, mineral targeting and exploration, site planning for Mx Racetracks, wetland surveying, and extractive oil exploration. They gear themselves towards researching for technology improvements in the maintenance of earth resources data collection. An attempt is made to motivate related technologies so the private sector can afford to use remote sensing in their decision making. They are working towards lowering the costs of producing information systems (CGISs) as well as lowering costs of sensor technology itself. Other research efforts are geared towards better ways to process images and large data bases. Design of hardware and software for contrast manipulation, change detection, magnification, and ratioing is also one of TRW's activities.

Summary of Survey Information

1. Structure of the Firms in the Industry

These companies all have multi-disciplinary skills, differing only in the distribution of the knowledge among the employees. Whereas one company may have a number of people per discipline, another may utilize only one or a few people that have knowledge of all the disciplines. The disciplines are scientists, engineers, economists and market specialists.

2. Products and Services

The companies typically supply an interpreted data product, processed from LANDSAT or other sources using image interpretation and CGIS systems. These products may take the form of a map, table, report, slide, or computer tape. Should it be required by the user, many suppliers can give recommendations for the user to pursue (e.g., where to drill, lay a transmission line, build a power plant, etc.). Some of the users, however, have enough expertise to make their own recommendations from the raw products. A one-shot software package may be created for the user that gives them the ability to interpret data themselves. The supplier will then typically give the user access to their own hardware (if the user doesn't have an in-house system) or someone else's on a time sharing basis, since most users apparently lack the capital or frequency of need to justify investing in their own hardware.

We can generalize from the sample descriptions of suppliers about the structure and activities of these companies. The larger supplier has a multi-disciplinary staff of experts, some in remote sensing, others, experts in other disciplines with relatively few remote sensing skills. Generally the large firms own computer hardware and support CGIS and image processing software. They offer consulting services that range far beyond basic data processing to include access to company-owned hardware and software; production of finished maps, tables, and reports; and even help in resource management decisions.

In contrast, the companies with small staffs require both applications and remote sensing expertise from nearly all staff members. The small supplier typically timeshares a university computer.

Most of both types of companies target the large user, but some of the small companies' methods reduce costs sufficiently to serve the smaller customer as well.

Table 1 lists the eleven suppliers reviewed here and the application areas in which they do analysis or consulting. Twenty-five applications of remote sensing or CGIS's are listed. Environmental assessment of impact studies, coastal and wetlands management, land use studies, and mineral mining and exploration are pursued by most companies. Larger companies such as EARTHSAT and Lockheed have the largest selection of application areas. Smaller-staffed companies, or those limiting themselves to one area, such as Ecographics International and EBASCO respectively, have less of a variety of application areas. Applications for utilities such as power plant sitings and transmission line corridor selection are pursued by only a few suppliers. Generally, however, these suppliers will do work in both applications. If an information product is produced for land cover and classification the supplier also does land use studies. These are some patterns in Table 1.

One tentative conclusion that our survey suggests relates to the structure of the ASVT's we will plan. The company which wants to target the small user must employ cost saving techniques. Because of the potential of the "untapped" small user market it might be most beneficial to model the structure and techniques of an ASVT (especially a small one) after a company like Ecographics International. The characteristics would be a follows:

1) Employs a small full time staff with multi-disciplinary knowledge, including remote sensing.

TABLE 1: "INFORMATION MIDDLEMAN" COMPANIES AND THEIR AREAS OF ACTIVITY

Suppliers \ Application Areas	land cover and classification	monitoring crop or vegetation development	crop forecasting	land use	wildlife habitat studies	wildlife protection and reserve planning	forest inventories and management	insect studies	crop inventories	solid waste management and landfill siting	monitoring environmental indicators	coastal and wetland management	ground water exploration	real estate and urban planning	water quality	waste water management	env. assessment of impact studies for various projects	mineral mining and exploration	oil exploration	power plant sitings	pipeline corridor selection	transmission line corridor selection	highway corridor selection	earthquake prediction	resource inventories and management
Burke and Assoc.	x	x		x								x		x	x		x				x		x		x
Comarc				x			x	x	x					x	x		x	x							x
Dames & Moore										x		x					x	x		x		x	x		x
Earthsat		x	x	x			x	x	x	x	x	x		x	x		x	x	x					x	x
Ebasco										x							x	x		x				x	
Ecographics Int'l				x	x	x												x							x
ERI.	x	x		x	x		x					x					x			x	x	x			x
ERDAS	x			x	x		x					x		x			x					x			
Geospectra	x			x								x	x				x	x	x					x	
Lockheed	x	x	x	x			x		x	x	x	x								x	x	x	x		
T.R.W.	x			x								x					x	x	x						

2) Is located in an area such that consultants and computer time are easily accessible (e.g. around a university).

3) Holds workshops to edudate the small user.

4) Defines initial user needs and draws up proposals at no cost.

Another preliminary finding, based on Table 1, is that there appears to be room in the market for more companies in applications not now extensively covered. These may include wildlife habitat studies and protection and planning, crop inventories, monitoring environmental indicators, real estate and urban planning, water quality, waste water management, corridor selection (highway, pipeline, transmission) and earthquake prediction. The feasibility of marketing information products in these application areas depends on the demand for these products and the users willingness to pay. The next sections of this report investigate these issues in some attractive application areas.

Task 2: Market Potential in Agribusiness

1. Current Information Use and Needs

Most of our research to date relating to the agribusiness community is based upon the work in the EODMS project of Jack Huisinga: Private Sector Short-term Information Needs and Potential Delivery Technologies. His work was conducted in the spring of 1978. Huisinga's methodology is presented as Appendix C to this report. Additional input has been provided by Mr. Huisinga, Dr. Christian Johannsen of the University of Missouri, and Dr. Marian Baumgardner of the Laboratory for Applications of Remote Sensing at Purdue University.

The following tables summarize many of the findings in a survey of agribusinesses. The industry groups surveyed are as listed in Table 2. The survey data indicate that approximately 40% of the firms responding feel the current reports of crop condition are too general or too late for their needs (see Tables 3 and 4). The greatest need for improvement was in timeliness of information. Specific information items in which improvement could enhance the operating efficiency of the respondent firms included the traditional crop information areas of acreage planted (or to be planted), the condition of the crop, and forecasts on total production and final yield. The areas for which information was needed varied from local (one county to six county areas) for the farm equipment manufacturers, to world production forecasts for grain traders.

It appears, however, that a new need is rapidly developing in another area. This may be termed "location assessment". It involves analyzing historical market data (for which timeliness is less important) and various efficiency factors to provide the information needed to make

Table 2

Information Use Characteristics by Agricultural Industry Groups

Industry Group	Purpose of Information	Primary Information Item	Indicator Used	Needs and Constraints	Comments	Current Information Expenditures	Individual Willingness to Pay for Improvements
Equipment Manufacturers	Locate and evaluate sales potential	Local farm income Export demand	Crop acreage forecasts Marketing data Crop stress Foreign production	Accurate, specific acreage data Timely stress reports Private use	Production lead time is approximately 2 years Sales follow farm income by 6 months	\$15000 ± ?	\$3000 to \$50000
Chemical Manufacture (fertilizer)	Locate and evaluate sales potential Timely delivery	Local farm income Local crop acreage Timing of field activities	Crop acreage Marketing data Local acreage estimates Crop stress Weather reports and forecasts	Accurate, specific acreage data Accurate weather forecasts Timely stress reports Private use	Must program deliveries during application activities	- 0 to \$50000	\$2000 to \$50000
Seed Producers	Locate and evaluate sales, current and future years	Local crop acreage Crop performance Stress and identification	Crop acreage forecasts Marketing data Stress and identification	Timeliness of reports	Production lead time is approximately 2 years	?	"lots" estimated less than \$5000
Grain Trade	Determine trading conditions and crop price Determine grain quality	Grain production Export demand Harvest progress	Most available crop indicators Crop condition and crop stress by agent	Proprietary use Timely condition reports Accuracy and objectivity of all measures	Activities are queued by USDA information Extensive forecasting, quantitative in nature	\$25000 to \$150000 (speculators) \$500 (commercial)	\$50000 or more \$500
Information Service	Inform clientele of events and conditions and their impact	Most items	Most available crop indicators	Foreign production forecasts Accurate, objective and timely acreage forecasts	Provide a wide variety of information	"little" to \$250000	0 to \$5000 (estimate)
Financial Service	Determine farmer credit worthiness	Farm income	Farm income reports			- 0	"little"
Land Management		Crop condition, stress and agent	Moisture conditions Stress and agent	Timely condition reports		0 to \$500	"little" to \$400
Crop Transportation	Determine demand and program services	Grain production export demand	Production and export forecasts			- 0	zero

Table 3

Information Needs of Agricultural Industry Groups Which Need Improvement or Remain Unsatisfied

Information Item	Needed Improvement	Relative* Need %	Industry Group: Need Unsatisfied	Industry Group: Improvement Useful
Crop Acreage	Greater Accuracy Smaller Area Specificity	10% - 20%	Chemical Manufacture Equipment Manufacture	Grain Trade Information Services Seed Production
Crop Condition	Timeliness	30% - 60%	Grain Trade Equipment Manufacture Chemical Manufacture	Information Services
Existance of Crop Stress	Local Specificity Objective Measures		Grain Trade Seed Production	Information Services
Identification of Agent Causing Stress	Timeliness		Chemical Manufacture Seed Production	Grain Trade Information Services Land Management
Export Demand (foreign production forecast)	Accuracy and Timeliness	30% - 50%	Grain Trade Equipment Manufacture	Information Services

*Relative Need % is the approximate proportion of willingness to pay for that item compared to all items as indicated by responses to the questionnaire.

Table 4

AGGREGATE RESPONSES TO QUESTION 4*

Could Better Information On:	Improve Efficiency? (Number of Responses)			
	greatly	modestly	slightly	none
Expected date of planting	7	8	19	14
Extent of planting, by crop	18	12	13	6
Expected production	27	11	7	3
Expected date of harvest	7	17	19	5
Crop progress and condition	22	15	9	3
Crop stress, by agent	22	14	9	4
Field moisture conditions	15	18	13	4
Location of crops, geographic and relative	4	14	19	9
Other (specified)				
Export demand	3	-	-	-
Weather	1	-	-	-
Planting and harvest progress	1	-	-	-
Weed infestation, location and extent	1	-	-	-

*Could you operate more efficiently if you had better information of the following types for the crop production region(s) of interest to your firm? Please check your response to each item in the appropriate column.

location decisions for business facilities serving agricultural producers. Increased pressure upon the agribusiness community to maximize efficiency has resulted in increased centralization of production facilities (e.g. fewer, but more efficient farms) and fewer but more efficient service and sales centers serving these producers (e.g. many previously marginal seed, fertilizer, and chemical shops are no longer profitable as the target population has given up farming in the area or been attracted by a more conveniently located competitor). The size of this need or any other quantitative values that may be associated with this need was not investigated by Mr. Huisinga, nor has it been investigated by anyone that we know of. We intend to pursue this avenue of investigation.

With regard to the willingness of the respondent firms to pay for improved information in the Huisinga study the author noted a caveat. Some portion of the willingness to pay assumes that access to the information is restricted. The value of the item to the firm is greatly reduced if that information is publicly available. In addition, it should be noted that the figures under "willingness to pay for improvements" in Table 2 could be supplemented with funds diverted from figures under "Current Information Expenditures" to come up with a sum indicating the total amount the firm would be willing to pay for improved information if it were to fill all or most of a firm's crop information needs.

Three basic relationships reflect the interest users of crop information have in the information provided them.

Production = Acreage x yield

Price = f(crop production)

Farm Income = f(crop price)

Many firms find it advantageous to have access to values for some portion of the production relationship in advance of when the values are easily predictable.

2. Current Information Sources

The U.S. Department of Agriculture (USDA) is the most widely used source for crop-related data. Half the respondent firms listed it as their most valuable source. The Economics, Statistics, and Cooperative Service of the USDA uses area frame sampling in the form of aerial photography and ground truth verification to yield forecast data after the growing season has begun. This sampling method is supplemented with list frame sampling - questionnaires sent out before planting for acreage planting intentions, as the crop is in progress for yield expectations and after harvest for final acreage and production. The Crop Reporting Broad uses the information to make its official reports. Current private sector information sources include subscription providers, publishers of newsletters and magazines, consultants, and in-house research by the ultimate users. Huisinga notes:

> "The primary differences between the public and private sector information activities are that the private system is amorphous, is more user or subject specific, and access to information is controlled by price to allow information advantages. The USDA information role supports that of the private information sources and other direct users. The private sources cannot afford, either individually or collectively, to collect and maintain a data base as complete as that of the USDA... Because (the information is needed as early as possible), ... frequent data reporting, special surveys, non-crop data, and heuristic interpretation methods play an important role in the private information process. Improved timeliness and accuracy of a forecast can provide information advantages."[1]

3. Needs Satisfaction by Selected Systems

Four currently in use systems were examined by Huisinga. Following are summaries of his findings on each.

The Statistics Service of the USDA/LANDSAT

The first system has been used experimentally to improve the accuracy of acreage reported in August for corn and soybeans in a 29-county area of Illinois. Coefficients of variation were reduced from 3.6 to 2.5% for corn and 7.7 to 5.2% for soybeans. Timeliness, however, was not improved. Such a system could detect the trends in differences between farmer's intentions and actual planting as of June. LANDSAT cannot detect planting intentions from soil preparation except in areas where a single crop predominates - as in western Kansas. Spectral differences in growing crops, however can be detected. Its advantage is in accuracy, as the LANDSAT imagery is unbiased. This system could therefore be profitably employed as a part of any "location assessment" service.

LACIE

LACIE was a joint research project of NASA, NOAA, and the USDA. It experimented with the use of LANDSAT imagery, soil characteristic data, and meteorological data (real-time) to determine wheat crop condition and yield forecasts. LACIE has substantially improved the accuracy and timeliness of crop condition reporting and yield forecasting for the Soviet Union in particular. USSR production forecasts, in May for Winter wheat, and in August for Spring wheat, have been within the 90/90 accuracy criterion: i.e. $\geq$ 90% of accuracy for $\geq$ 90% of the forecasts.[2] Comparable figures for USDA USSR production forecasts before LACIE were 50/90. The USDA has adopted this method for Soviet yield forecasting.

CROPCAST®

CROPCAST is a proprietary grain information delivery system provided by the Earth Satellite Corporation of Washington, D.C.

CROPCAST forecasts acreage earlier than the USDA based on historical figures, i.e. grain prices at harvest, crop acreage and yield for previous year's harvest, and other socio economic figures that may be relevant to the area examined. In the U.S.S.R., for example, this might include published goals for the area's production. Incoming data is processed through models developed by the corporation to provide forecasts of acreage before the USDA information becomes available.

Yield forecasts are produced from daily meteorological information, soil characteristic data, historical data, crop varietal data, USDA data, and some use is made of LANDSAT imagery. The user may specify information desired and CROPCAST can provide such information as estimated soil moisture, percent of crop stressed, and percent of crop recoverable at any temporal interval required. The system specializes in wheat, corn and soybean forecasts. It has been 96.4% accurate in yield and production forecasts in the northern hemisphere according to company literature. CROPCAST deals primarily with wheat, corn, and soybeans.

Purdue Alfalfa Pest Management Project

This is an example of biotic modeling to predict the potential impact a pest may have on a crop. In this case the pest was the alfalfa weevil. Output from an alfalfa weevil growth and population model and output from an alfalfa growth model were input into a plant-pest model to provide a forecast on the pest impact on alfalfa production.

A summary of findings is noted in Table 5.

Table 5

Characteristics of Four Information Systems

System and Operator	
SRS/LANDSAT — Statistical Reporting Service	Output: Small area crop acreages down to county-sized units. Estimates are superior to current SRS estimates. Private acquisition is possible. Input: SRS sample data and LANDSAT imagery. Method: Correlation of SRS and LANDSAT acreages. SRS enumeration unit data trains the image classifier. Limitations: Needs SRS field observations. Timeliness limited to growing season observations. Primarily corn and soybeans to date. Status: Demonstration. Costs: several hundred dollars per estimate
LACIE — NASA NOAA USDA	Output: Acreage estimates, yield and production estimates and forecasts for national and international wheat growing regions. Input: LANDSAT imagery for acreage estimate. Meteorological data for yield forecasts. Method: Classification of sample cell from multiple images. Yield forecasts from truncated models regressing meteorological data on yields. Status: Test Applications System. Limitations: Wheat only to date, other crops are more difficult to locate. Output is constrained by Crop Reporting Board schedule. Costs: Development costs of \$10 million per year for 3 years. Acreage estimate comprises 85% - 90%.

Table 5

Characteristics of Four Information Systems
(continued)

System and Operator	
CROPCAST — Earth Satellite Corp	Output: Acreage forecasts and estimates, crop condition assessment and indicators, yield and production forecasts. All crops and regions offered. Daily forecasts if desired. Input: Socioeconomic and SRS data, meteorological data, some LANDSAT. Methods: Acreage from regression. Crop Simulation model. Status: Products offered for sale. Limitations: No comparable standards to compare some output items. Costs: $3 million in development costs. Items vary. Example: exclusive corn estimates for perhaps $250,000 per year. Less if non-exclusive use.
PAPMP — Purdue Extension Service	Output: Timing and impact of alfalfa-weeval on alfalfa in Indiana. Other intermediate information possible. Two week forecast. Input: Local and specific meteorological data, pest counts (to date). Method: Simulation of plants, pest, and interaction. Limitations: Field observations necessary to date. Needs specific meteorological data. Significant crop-specific development necessary. Status: Pilot project. Cost: Development unknown, $1 per acre per year subscription for growers.

4. Current Information Expense and Willingness to Pay for Specific Items

Current expenditures in five of the segments studied - chemicals, equipment, grain trade, and information - were at a mean of $57.6K @. willingness to pay for improved information was at a mean of < $8.3K. The equivalent figures for the remaining segments were substantially lower.

5. Suggestions for System Development

Any system developed for agribusiness must fulfill the user need criteria referred to earlier, i.e. timeliness and accuracy. Timeliness is the key element in the CROPCAST® system. Accuracy is the key element in the USDA/LANDSAT system. Some respondent firms use their own forecasting models and keep their own data base from which models may be updated. The advantage of such individual information extraction is its proprietary nature. If, however, improved timeliness and accuracy as well as even limited proprietary protection could be gained through outside purchase of the information then the likelihood of financial success by an enterprise in this area would be substantially enhanced.

The timeliness of any forecasts dependent upon LANDSAT imagery would be enhanced if the imagery could be received in the form of computer compatible tapes within a week of their recording by the satellite. Direct access to the CGIS of incoming real-time meteorological data from the National Weather Service could further enhance this system's efficiency. Current systems use meteorological data as part of the data base for modeling but wait for forecasts from the NWS. Theoretically, information services could produce their own forecasts from incoming data.

Any system would by necessity include data on many variables: i.e., historical data on crop yields and production for selected geographic areas, geographic variables such as soil moisture retention characteristics by soil composition, moisture levels at which stress begins for various crops, climotological data, crop variety data, pest distribution and associated bio-model if used, LANDSAT imagery and computer-extracted information on acreage and condition of the crops under study, aerial photography-extracted information, LANDSAT/Aerial photography associated ground-truth verification, and any other variables selected for use in a CGIS servicing the information needs of the agribusiness community.

Personnel with expertise in various fields are needed: statistical-modeling and computer programming, agronomy, and meteorology. In addition, market experts in the agribusiness specialties served should be maintained on a consultant basis. It is more efficient for the information service to acquire market expertise than for each company served to keep current on developing remote-sensing and information processing technology.

The computer capacity needed to handle data base and programming requirements for versatile and timely processing of continually incoming data is substantial. A recent inquiry into the cost of such a system found it to be $40K/month to lease and $500K to purchase outright. Computer time-sharing would compromise the proprietary nature of the system and information contained therein. The system is expected to cost an additional $500K to develop. It is significant that CROPCAST® cost $3M to develop according to the Earth Satellite Corporation. More investigation into the needed computer capacities and associated costs

for various CGIS designs will need to be undertaken. It may be noted that the new LANDSAT D is expected to contain 27 times more data/scene than the current LANDSAT. This in itself may affect required computer capacity of any CGIS which makes use of LANDSAT imagery.

It is likely that an ASVT design to serve the locational assessment needs of the agribusiness community, referred to in the introduction to this section, would not require such a substantial processing capacity but would instead require greater specialization in the industry served and expertise thereon. Thus the hardware costs may be less, but the staffing expenses may offset this. The inherent financial risk could be minimized by hiring experts on a temporary basis as they are needed to fulfill specific contractual requirements.

6. The Continuing Investigation

Interviews will be conducted with selected firms in the agribusiness community. The interviews are expected to provide more detailed input on current information sources and use by the firms. An additional aim of the interviews will be to familiarize consulted firms with the potential of a CGIS. The extent to which greater familiarization with CGIS capabilities influence a firm's willingness to pay for the improved information will be noted. Except for the USDA statistics service techniques, all forecasting systems currently in use have been to a large extent developed within the last ten years. Later follow-up could note the extent to which firms have acted on this familiarization.

Specific CGIS designs and product-proposals will be examined for feasibility, cost, and revenue generation potential. Sensitivity analysis

will be undertaken to provide an idea of the affects of changes in any of the assumptions in the cost or revenue variables.

7. Summary

The market for a CGIS and/or LANDSAT based enterprise to provide information to the agribusiness community has potential which will be investigated further. Potential exists primarily in providing more timely and accurate marketing information than that which is currently available. Developing remote-sensing technology and processing systems utilizing CGIS's should provide substantial entrepreneurial opportunities in the future as user firms become increasingly familiar with system's information delivery potential. Dissatisfaction with more traditional sources of information may lead to the necessity by firms to purchase processed information from outside the firm either in addition to or in place of previously utilized sources of crop and market information.

A company could be developed around the perceived markets for information. In regard to the provision of timely data, three large stratified market levels can be identified: 1) the largest companies willing to pay the most for the earliest possible data, 2) the smaller firm willing to pay for less expensive consultant advice or processed data in not as timely (early) a form and in an easily interpreted format and 3) the consumer who in times of continually expanding world demand for agricultural products finds himself constrained by little or no growth in his purchasing power. A central clearinghouse of agriculturally related information could serve these stratified market levels from a

common data-base with little additional expense as opposed to serving only one level of the market.

In regard to location assessment, the need for expertise requires that a single industry within the agribusiness community be selected as a target market for the services of a CGIS. The continuing investigation should help pinpoint the most promising industries for such a service. Potential clientele include elevator operators, fertilizer, chemical and seed distributors, and farm equipment manufacturers.

The high development cost compared to its revenue generation potential if used by a single firm and the rapid pace of continuing refinements in these systems inhibits the in-house development of computerized geographic information systems except by the largest firms. It is possible even extremely large, sophisticated firms would find it beneficial to subscribe to outside information in addition to in-house information generation and indeed, it appears the larger firms are currently more willing to invest in such information.[4]

Footnotes

1. Huisinga, Jack, Private Sector Short-Term Grain Information Needs and Potential Delivery Technologies, Masters Thesis, Technology and Human Affairs, Washington University, St. Louis, Missouri, 1978, p. 57.

2. R. B. McDonald and F. G. Hall, "Globe Crop Forecasting," Science, May 16, 1980, p. 675.

3. Op. cit., Huisinga, p. 5.

4. Op. cit, Huisinga, p. 15-16.

Task 3: Business Opportunities in Urban Information Systems

Urban application of computerized information systems offers extensive possibilities of profitable private sector involvement. The close proximity to potential users, personnel familiar with computer systems, and data sources makes urban centers ideally suited for business opportunities. Within an urban area, the information requirements of both public and private sector are numerous and varied, creating a climate that is conducive to new enterprise.

Investigation to date has revealed that a number of firms have already entered into the data market and are performing profitably. The information needs of both the public and the private sector are growing fast and many smaller private firms that provide demographic information have formed during the 1970's. These firms are usually small business and operate in an efficient, responsible manner, reflecting the needs of their customers.

Generally, the customers of these small data companies are also small private concerns. For example, a small retail chain may request demographic data to plan for future expansion, identify new customers, or to measure their success. Small manufacturers of consumer products also can benefit from demographic data to plan future expansion or modify distribution networks to keep pace with population shifts. To a limited extent, some of these firms have sold data to smaller localities or municipalities that have neither the manpower nor the expertise to do the work themselves.* Larger private firms generally do not buy

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*Finlay, Daniel: "How Small Business Can Profit From Demographics," American Demographics, May 1980.

data from these companies, as they are large enough to have their own demographic staff.

The primary source of information used by data companies is Census data which they manipulate, analyze and present in a form that meets their customers' needs. The cost of the data is usually not great for standard demographics, but specialized reports incur additional costs. The growth of these data companies is sound evidence that a market is available for the entrance of a new business dealing in computerized information systems.

The range of possible users and markets for urban application of CGIS's is very broad. We have assessed two areas with apparent potential for our project's needs: information systems for industrial or residential urban redevelopment and for municipal planning. The following text discusses results to date of these investigations.

1. Applications for Industrial and Residential Redevelopment

We carried out an indepth study of information requirements on urban, industrial, and residential redevelopment for the city of St. Louis. We examined three organizations that represent various types of redevelopment activities in St. Louis. The Planned Industrial Expansion Authority (P.I.E.) deals with industrial redevelopment. The Community Development Agency (C.D.A.) is a multi-faceted city agency concerned with both residential and industrial planning. Pantheon Corporation is a private development company whose activities center on residential redevelopment.

Redevelopment of urban, industrial, and residential properties is, in most cases, controlled through state statutes which authorize and

establish guidelines. To assist redevelopment in conjunction with these statutes, the city must designate an area as "blighted." The blighted designation allows the corporate tax abatement, federal funding, and other privileges to motivate redevelopment.

In order to fulfill statutory requirements, redevelopers must submit specific information to city agencies or governmental bodies in the development plan for the blighted area. The development plan guidelines may ask for different types of data, from cost estimates and financial arrangements, to demographic information such as unemployment figures. In addition to the data required by law, the redeveloper has a need for information essential to the implementation of a development plan such as architectural drawings or utility maps. Marketing the property requires that building and site information be collected, stored, and updated in order to inform prospective buyers of property availability and characteristics.

Industrial Redevelopment Information Requirements

Planning for industrial redevelopment projects entails the use of technical engineering information and cost estimates for utilities and facilities improvements. Although generating some information internally, concerning land use, land acquisition and disposition, and a general description of the project area and vicinity, P.I.E. employs consultants (at up to $60,000 per major site) for plans for utilities improvements, estimates of the total capital expenditures for improvements, and relocation plans for residents and businesses located in the area. The consultants may be the city's Board of Public Service or private engineering

or architectural firms. Table 6 presents planning information requirements of the industrial redeveloper which might be served by a computerized geographic information system.

The marketing of industrial property requires information that is more specific and must be accessed fairly frequently. Prospective industrial buyers contact P.I.E. to obtain building and site information about the agency's property. This information varies according to the needs of the specific business. Data items provided by P.I.E. to its customers are shown in Table 7. These information items could be incorporated into a computerized geographic information system.

Residential Redevelopment Information Requirements

Although the information requirements for a residential redevelopment plan are more extensive than for the industrial plan, the nature of the requirements are such that the redeveloper does not have to engage in complex data manipulation to answer development questions. For instance, one section of the development plan calls for a description of the portions of the project to be sold, donated, or leased to public agencies, together with the terms of the proposed sale, donation, or lease. Since this determination is largely up to the discretion of the developer and public agency, it is uncertain as to whether this information could be efficiently incorporated into a computerized geographic information system. Table 8 lists the information requirements in a residential redevelopment plan which might be suitable to include in a computerized system. Residential redevelopers must submit full construction or rehabilitation plans and plans for proposed street improvements. Pantheon utilizes private engineering or architectural firms to draw up

Table 6

Industrial Information Requirements - Planning

- Land use classification, e.g. commercial, residential, institutional.
- Building classification, e.g. single family dwelling, warehouses.
- Population density.
- Utilities placement, e.g. telephone lines, sewer systems, street lights.
- Percentage of minority population.
- Unemployment statistics.
- Zoning.
- Street placement.

Table 7

Residential Redevelopment Information

Site Information

- value of property
- property boundaries
- square footage or number of acres
- zoning
- surrounding land use
- highway access
- rail access
- barge access
- airport access
- utility availability
- topography

Building Information

- value of building
- square footage
- type of construction
- condition of structures
- office space
- ceiling height
- fire escapes and sprinklers
- security fences
- parking
- utility availability
- truck dock
- highway access
- number of floors
- bay size
- rail access
- port access
- expiration of present tenants' leases

Table 8

Information Requirements for Residential Redevelopment

- Legal description of property.
- Legal description of real property to be included in each stage.
- Portion of development left as open space.
- Character of existing dwelling accommodations.
- Approximate number of families residing in dwelling units.
- Schedule of rentals being paid by residents.
- Schedule of the vacancies in such accommodations.

these plans. Pantheon Corporation, which has done $47M worth of residential redevelopment in St. Louis since 1973, also requires marketing information, because it acts as a real estate agent for about half of its completed residential property.

Conclusions of the Urban Redevelopment Investigation

Marketing opportunities for computerized geographic information systems exist within redevelopment organizations and related agencies. Potential users of a CGIS might include P.I.E, C.D.A., private engineering and redevelopment firms, and real estate companies.

P.I.E.'s marketing information needs could be met by a computerized geographic information system. Presently, the marketing representatives at the agency must retrieve data concerning available property manually. The marketing department receives approximately five inquiries per day from St. Louis firms. P.I.E. would be better able to serve to its customers by providing quick, accurate information on industrial property. Questions asked by prospective buyers may require many different pieces of information combined in a variety of ways. For example, a business might be trying to locate a piece of industrial property of a certain square footage, with highway and rail access, and specialized utility availability. The data base could be accessed several times as information requests from the prospective buyer become more specific. A computerized geographic information system has the advantage of being able to combine a large amount of information to answer these questions. One disadvantage of such a system is the necessity of updating the information in order to maintain accurate data files. P.I.E. is also an

attractive customer in that it is not a city agency and is not necessarily tied to the city's information system. The agency is relatively free to purchase information from a supplier offering a low price or attractive information package.

P.I.E. has proposed to build a data base to meet their data needs, but as of yet nothing has been completed. However, an outline of the proposed data items is presented in Table 9. This table gives a good indication of the data requirements needed to meet industrial land redevelopment criteria. The possibility exists for a new business to form a data base similar in content to this one proposed and have a market available in the redevelopment area.

A computerized geographic information system might be useful to C.D.A. for evaluating and monitoring residential redevelopment plans. Data concerning the existing residential areas could be combined with the information provided by the redevelopment plan. If C.D.A. is evaluating more than one plan for the same residential area, a CGIS would be useful in comparing the different plans. After a development plan is passed by the Board of Aldermen, the original data about the area could be stored with changes proposed by the development plan in order to monitor the progress of the project. The difficulty with selling information to C.D.A. is that as a city agency, it may be committed to the local government information system. Local governments have shown an interest in establishing their own information systems in spite of uncertainty and inadequacy of funding. A supplier servicing C.D.A. would be likely to encounter competition from internal information systems.

Table 9

Industrial Land Inventory System Proposed Data Items

1. City block number
2. Tax parcel number
3. Structure address number
4. New locator code (numeric name of respective street)
5. Zoning code
6. S.I.C. code (primary and secondary)
7. Land square feet
8. Improvement square feet (floor area of respective structure)
9. Number of floors
10. Building number (when more than one structure is built on a parcel)
11. Industrial district number
12. Ceiling height
13. Bay size
14. Office size
15. Elevators (number of freight and passenger elevators)
16. Sprinkler (type of sprinkler system)
17. Air conditioning
18. Heating
19. Construction date
20. Building construction class
21. Insurance class
22. Fire group
23. Parking
24. Rail access
25. Rail dock
26. Barge access
27. Barge dock
28. Truck access
29. Truck dock
30. Lease expiration date
31. Special district (e.g. flood plain, historic, etc.)
32. Central business district code
33. Topography
34. Presence of utilities
35. Availability/occupancy status
36. Contact (if site is "on the market")

Two other potential users of a computerized geographic information system include private engineering firms and real estate companies. Although these organizations are not directly involved wtih redevelopment, their information needs appear to be complementary. Engineering firms provide input to a redevelopment proposal in the form of construction plans, maps of proposed improvements and cost estimates for the project. A CGIS which could map the location or placement of major utilities, sewer lines, street lights, etc. would be useful in conducting improvement surveys. One major drawback in such a system is updating utility information. Moreover, some of the utility systems in St. Louis are 150 years old and obtaining accurate utility plans for data input might be difficult.

Real estate companies might also provide a potential market opportunity for a computerized geographic information system. If the company does a large enough volume of business, a CGIS would be useful in answering questions from prospective buyers. The advantage and disadvantages of such a system would be similar to those proposed for P.I.E.

2. Application for Municipal Planning

One project staffer conducted a second investigation concerning the possibility of using the Census DIME file to form a CGIS from data presently maintained by municipal governments. The project proposed to use selected data items from the St. Louis County government data base and merge these records with the St. Louis County DIME file to form a geocoded data base of municipal data. Potential users of the data include municipal, county, state, and federal government; real estate firms; marketing or advertising concerns; and other business marketing in St. Louis County.

The DIME file mentioned in the previous paragraph is a unique data base that can be merged with local data bases to form a geocoded database. Geocoding, which gives a geographic method of analyzing data, is the essence of a CGIS. The Census Bureau maintains a DIME file for the urban core of all Standard Metropolitan Statistical Areas (SMSA) in the United States. There are approximately 200 SMSA's and each is defined as any urban area with a population over 100,000. A more detailed description of the DIME file and the project is provided in Appendix D.

Initially, the proposed new computerized geographic data base was to be built around the information needs of municipal officials to deal with planning problems; however, it was also recognized to be of potential value for those in the real estate area. The methodology used to determine the contents which best suited both municipal officials and real estate personnel, was through questionnaires completed by both parties and through personal interviews. The detailed results of this public input to the data base formation are presented in Appendix D.

In brief, the results of the survey indicated a desire on the part of municipal officials and real estate personnel to have data concerning population estimates, land use, average age of residential and commercial structures, and also the number and percentage of owner-occupied housing. In presentation of the data, aggregation of the municipal level was desired on an annual basis. An area that generated great interest was changes in the data over time in order to make comparisons with previous years. Based on these results, a CGIS could feasibly be developed in the private sector which contains this type of data. Access to the DIME file is not restricted; however it is not known at this time the access restrictions to municipal data bases.

The intended future course of study in this area is to locate additional municipal data bases that would be of great value in an urban CGIS and then determine the restrictions on their use. Also, urban applications of the DIME file will be investigated as the DIME file provides an accurate base from which to begin building a CGIS. It is expected that other types of data can be merged with the DIME file to produce potentially marketable information systems.

3. Future Investigation

Following these investigations into urban redevelopment and municipal planning, we are planning to take a closer look into these and other urban information system applications as potential ASVT's, including real estate, marketing, public relations, advertising, insurance, banking and credit, among others. Beginning with a major brainstorming session, we will explore multiple ASVT prospects, both current and futuristic. Following the selection of promising ASVTs, we will carry out a detailed market analysis.

Our proposed methodology for investigating an urban ASVT application involves the four-step procedure outlined in Table 10. Prior to field analysis, we plan to determine probable market customers in potential ASVT areas through initial brainstorming and interviewing techniques. Among the questions primarily to be considered, for instance, are "who would be interested in using the various data-bases offered by ASVT's within an urban area?" "How often and in what format would such users require the data?" "Do users represent public or private concerns within or out of an urban area?"

Table 10

Methodology for Investigating Potential ASVT's in Urban Information Systems

I. DETERMINING POTENTIAL CUSTOMERS

Questions to be considered:

(A) Who would be interested in data?

(B) What data do they want to see?

(1) Standard

(2) Supplementary

(C) What format do they want data (e.g. tapes, printouts, graphs, etc.)?

(D) How often do they want data (i.e. quarterly, annually)?

(E) Where are they located?

(F) Classification:

(1) Government, including
Public Planning Offices
Transportation Authorities
Recreation Agencies
Census Bureau (housing appraisals, income levels, minority mix, etc.)

(2) Non-government, e.g.,
Utility Companies (electric, telephone, water, sewers)
Transportation Agencies
Regional Commerce and Growth Association
University Facilities

(G) Do these structures apply:

(1) Proprietorship?

(2) Partnership?

(3) Corporation?

Proposed Methodology for Part I

Brainstorming

Personal contacts and interviews

Investigate existing urban computerized information systems (UDIS, MIS, etc.)

Make inquiries with Regional Commerce and Growth Association

Utilize investigations of research associates

Table 10 (continued)

Methodology for Investigating Potential ASVT's in Urban Information Systems

II. WHAT CAN "WE" OFFER?

Questions to be considered:

(A) What types of data combinations?

(1) Standard

(2) Supplementary (special requests)

(B) What forms of presentation?

(1) Printouts, card decks, tapes, computer maps, etc.

(2) Consulting services (special requests)

(C) Can sample reports be produced?

(D) Areas to be serviced:

(1) City?

(2) County?

(3) Major outlying suburbs?

(E) Frequency of updating?

Proposed Methodology for Part II:

Analysis of market research.

Request samples from existing CGISs; samples may be found in documentation of these systems or in other research materials.

Table 10 (continued)

Methodology for Investigating Potential ASVT's in Urban Information Systems

III. LEGAL AND ACCESS IMPLICATIONS

Questions to be considered:

(A) Authorization:

(1) Can we get the data from the files? (How much? To what level?)

(2) To whom can we distribute the data?

(3) Are there any restrictions whatsoever?

(B) Is there encroachment on privacy?

(C) General business laws.

Proposed Methodology for Part III

Make professional inquiries of:

lawyers, managers in business, professors, and other accessible, qualified personnel.

Raise these questions during personal/phone contacts.

Research documentation of existing urban information systems for potential issues.

Table 10 (continued)

Methodology for Investigating Potential ASVT's in Urban Information Systems

IV. FINANCIAL FEASIBILITY

Questions to be considered:

(A) What are the costs involved?

(1) Computers

(a) Hardware (on-line vs. off-line)
(b) Software
(c) Lease vs. capital investment

(2) Forming a Database

(a) Collection
(b) Maintenance

(3) Processing and distribution of data packages

(4) General "business" expenses

(B) Profitability:

(1) Could such private sector involvement be profitable?
(2) How long before break-even point is met?

(C) Should sales programs include:

(1) developing new formats for data distribution?
(2) locating new customers?
(3) locating new sources?

(D) At what scope should the entrepreneur operate:

(1) Urban?
(2) Regional?
(3) State-wide?

Proposed Methodology for Part IV

Perform business analysis to appropriate degree.

Make inquiries via personal contacts.

With some indication of what constitutes the market for the proposed businesses, our next consideration is what a small business can offer to customers: "can we offer not only a standard set of data periodically, but a supplementary package per special user requests?" "Will various forms of data combinations be provided, such as tapes, printouts, and computer-generated maps?" Consulting services could also be an option. Interviewing a number of public and private firms in the area will enable us to gain insight as to what are the specific data requirements in the city, county and major outlying suburbs. Details regarding data format, accuracy, timeliness and compatability to existing data systems may be accessed for verification. Comparison to other urban areas may then be made.

During this field investigation, we hope to discover any legal restrictions that might hinder the ASVT regarding authorization of collecting and distributing data, violations of privacy, and, in general, business laws pertinent to establishing a private company. Not only are we prepared to inspect the material collected from interviews and other operative urban information systems* for this information, we plan to obtain professional advice from lawyers and other experienced personnel as well.

Our last remaining step is a detailed financial feasibility analysis which will require the assistance of finance expertise available within our project. Investments in computer facilities, collecting and maintaining company data banks, processing and distribution of data packages are

*For example, Urban Development Information System (UDIS), Fairfax County, Virginia and Municipal Information System (MIS), Wichita Falls, Texas. Although currently not operating, Land Use Management Information System (LUMIS), Los Angeles, California.

major factors that should be under consideration. Questions concerning profitability margins and sales policies need to be analyzed also.

Task 4: Opportunities in CGIS or Remote Sensing-Based Consumer Information Products

A family searching for a new home contacts a realtor to obtain a list of houses available in that locale. As a new service to attract more clients, this realtor lists their houses in a special "magazine" format. In addition to the traditional information usually listed with a home, this magazine lists, for each house, the essential services in a five-mile radius, such as number of supermarkets, acres of parkland, location of mass transit systems, number of hospitals, and size of the public school system. It also provides pertinent statistics of the specific neighborhood, such as the mean age of homeowners and children, average number of children per house, seasonal air quality indices, and population of township (or political locale).

This example demonstrates one of the many capabilities of computerized geographic information systems (CGIS) available for direct consumer applications. At a potentially small expense to realtors, they can develop a package of information for any house in their district. With this information buyers could choose between houses using their own standards of subjectivity. The consumer's information needs are satisfied and the realtor gains another trade tool; here the CGIS is helping all parties involved.

The commercial sector currently funds sources of consumer information services to attract business. Probably the most familiar and indentifiable consumer application of an information service in daily use is the weather reports aired on TV and radio. Meteorologists employ computers, satellite remote sensing, and ground truth data to present a

comprehensive report. Advertisers fund this popular information service to their benefit and that of the audience.

The uses of CGIS's or remote sensing for consumer services are limited only to the extent of the data base one is capable of compiling and maintaining. Information "middlemen" who operate these systems can draw on census data, city and county agencies, realtors, utilities, and LANDSAT data to fill their information needs. Along with collection of the data, analyzing and interpreting the data to fit specific user needs is a major task.

As in the cases of media weather forecasting and the real estate listing magazine, other attractive areas of consumer application for CGISs/remote sensing could be funded and promoted by the commercial sector. These firms would undertake the expense of providing the information to attract customers.

For each service we investigate, we can calculate the utility that businesses place on attracting more customers to determine willingness to pay, even when we do not know the value that consumers place on receiving the information. One of our aims, however, will be to survey consumers to determine their utility for information to aid us in constructing a firm to serve them.

The following text describes four of our preliminary ideas for CGIS or remote sensing-based consumer information services in more detail. It also explains our plans for further assessing these ideas.

1. <u>The Realtors' "Magazine"</u>

We believe that the realtor CGIS listing magazine idea may be sound enough to support an ASVT. To investigate it further, we will employ the

following questionnaire (Table 11) to survey realtors to establish the priority of information needs. In implementing the idea, the ASVT can concentrate initially on the information this survey identifies to be high priority. Our research on this product will also determine the geographic limits of each magazine. We have considered the legal hurdles involved with publishing this information, and apparently there is no legal problem. Designing the information middleman's firm will follow naturally the information needs and their priority, and the amount of money available for the project.

2. Travel Information

Travel agents and freight forwarders represent another industry that we have targeted as potential users of CGIS. The amount of information currently available to travelers, for example, is only a fraction of what they need. A person planning a family trip, say between Boston and New York, needs to determine the best route, the most economical mode, as well as the most convenient schedule. All necessary information may not currently be available. In our example, say the traveler decides to fly because the airlines offered the best family rates, but upon arrival discovers the terminal was far from the destination. Too late, one might find that the train was less expensive since it terminates downtown.

Travel considerations are built on a pyramid of questions: what are the relative costs of each mode; where are the termination points; what are the costs of tolls on route; what is the availability of lodging on the highway; what child care facilities are available; is the hotel anywhere close to the terminals; what are the schedule times; are there

Table 11

Questionnaire for Information Needs for the Realtor's "Magazine"

Grade each information need on a scale of one to five (five highest) as to the level of importance a home buyer would place on having these additional facts during their shopping phase.

___ Mean and medium age of home owners on block

___ Average number of children per house on block

___ Mean and medium age of children on block

___ Number of houses sold per year on block

___ Property taxes per $1,000 assessed value of house

___ Seasonal air quality index for neighborhood

___ Size of public school system

___ Population of township (or political locale)

Geographic (and Essential Services)

___ Number of supermarkets within five mile radius

___ Acres of park land within five mile radius

___ Number of tennis courts within five mile radius

___ Number of hopsitals within five mile radius

___ Mass transit system within five mile radius

___ Number of highway accesses within five mile radius

___ Perferred size of your radius survey

Other Information Needs not Listed.

A.

B.

C.

cancellation fees; and the list goes on. Answers to these questions would make trips smoother.

The use of a CGIS in this application would be ideal. A travel agent could not possibly know the information for each trip nor would they have the time to calculate all factors pertinent to every individual problem. Using the agent's CRT, a family could plot a trip and choose the mode most cost effective for them. It is possible that the family chooses the most expensive because it is the simplest with children, but at least they know why they made their choice. With the CGIS system the travel agent would become a greater service and would be able to attract more marginal customers.

The travel industry lends itself to this application because agents are located in every city, already have some computer facilities for reservations, and are local sources of inexpensive data update. Freight haulers could avail themselves to the same CGIS technique and learn to be more cost effective, an important concern with growing decontrols. We plan to elaborate on the data needs of this industry and design the data base necessary to make these programs functional and economical.

We plan to survey St. Louis area travel agents -- both nationally and locally based -- with a questionnaire like that in Table 12 in order to determine the proper product concept ideas. The results of the survey will give us the basis to design a CGIS around, as if we were the information middleman whose company will do it in the future.

Our financial analysis will investigate how travel agents should acquire this service -- whether to rent, lease, or buy. Calculations using a probability distribution of additional business the

Table 12

Proposed Information Needs Survey for the Travel Service/Freight Transport Application

This survey is being conducted in cooperation with NASA to design and implement commercially applicable computerized geographic information systems. We have targeted the travel service industry as a viable candidate for expanding the existing computer hardware and software capabilities.

Please grade each information need on a scale of one to five (five highest) as to the level of importance your client would place on having these additional facts while planning their activities.

___ List of all available means of travel and costs (i.e, hotel, relative)

___ Terminal point in reference to destination

___ Special travel packages available and restrictions

___ Special child care accommodations

___ List of connecting transportation

___ Mass transit connections between points of interest

___ Necessary vaccinations or health restrictions

___ Visa requirements

___ Currency exchange rates

___ Per centage of English speaking population

___ Local festivals during visit

___ Hotel and resort accommodation rates

___ Health service accommodations

___ Entertainment facilities

___ Package tour travel restrictions

agents believe this service should attract, we should be able to determine how much funds a typical agent of a typical size will be able to afford to set aside for this project.

What the business in this area will ultimately develop is a program which travel agents should be able to "plug into" easily. They will have the list of available data, form of data transmission, necessary hardware and software, and ways of financing this program.

3. The TV "Food Person"

A face that could become as familiar on TV as the weather person could be the agriculture forecaster. Already on the local news are grocers showing the best fresh vegetable buys and giving hints on how to recognize good fresh food. The limitation of these features is their lack of insight into other regions, crop futures, and commercial crop demand. For example, if tomato crops were doing poorly nationwide, this forecast would be an early warning to try and get some produce early and can it. Prices will be high for fresh and commercially canned tomatoes and by following the forecasts the consumer could be prepared.

Another feature of the report could be instructions on freezing produce and meats, combined with forecasts of meat prices to identify best times to buy. LANDSAT's application in agricultural forecasting should play an important role in this service, much as weather satellites do in TV weather forecasts.

4. Public Utility Information to Customers

Utilities concerned about their public image as polluters might use CGIS plots of remotely-sensed pollutant measurements to communicate factual

information to consumers. By plotting the air and water quality in their region during low-demand and high-demand operation, a utility could delineate its contribution to air pollution, daily if necessary. If the contribution is small, the company could put fears to rest. If not, consumers' groups might pay to have a means to monitor utilities whether they cooperate or not, since the consumer's quality of life depends on conscientious service.

5. Two-Way Cable TV as a Consumer-Information System

A relatively recent implementation of a consumer-oriented/information distribution system which shares the cost of distributing information with the user is the two-way interactive cable television system, an outgrowth of cable TV. Each subscriber, (such as in one pilot city, Columbus, Ohio) is provided with a 30 channel selector. (Houston will have 104 channels). The full scope of programming accessible to the viewer includes channels of education, entertainment, and information.

This system, operated by Warner Communications, is known as Qube. The viewer interacts with the system with a small, limited-capacity computer terminal/selector console. Systems of this nature would permit every subscriber to interact directly with a CGIS type system at the studio. Questions such as locations of restaurants, their menus, prices, and hours of operations can be submitted. Whatever information a shop keeper or government agency wants to convey can be made immediately accessible through systems of this nature.

These interactive systems also lend themselves to educational programming. Students can respond directly to questions by the teacher which

gives the instructor a good idea of the progress of the class. The CGIS associated with the educational program could also be utilized as an information base for continuing study at home.

If such systems could extend to rural areas, farmers would be eager to be able to call up information regarding weather forecasts, the local availability of feeds and rental equipment, crop price futures, and the location of combine crews. Because of the nature of farming today, farmers are sophisticated businessmen who demand accurate information.

There is no limit to the different types of information that can be made available in these systems. Currently there is a shortage of hardware for system subscribers to use. As soon as it becomes cost effective the necessary home terminals will appear on the market. We will investigate the hardware, software, and information requirements of these systems and simpler distribution schemes in order to make a CGIS/remote sensing based information system cost effective for mass use.

Task 5: Commercial Applications in Forestry

Our initial survey of "information middleman" corporations (Task 1) shows the application area of forestry is relatively new. We have begun a second survey of the forestry industry itself. Potential customers in forestry are the U.S. and State Forest Services; large lumber corporations; the paper, building, and other wood-consuming industries; small woodlot owners; and perhaps individuals who are building with, or buying, lumber.

Preliminary contacts have been informative and helpful in assessing forestry information needs. Table 13 presents an analysis that we have made of information needs. We drafted this table from EODMS results and updated it with feedback from forest industry representatives. Other needs in the industry are for information on forest resource variance, market trends, geographical information related to expansion and planning, and many more. Presently LANDSAT can supply a portion of these needs. If LANDSAT is combined in a CGIS with ground truth data and aerial reconnaissance of specific areas, many more of these information needs can be satisfied accurately. Most LANDSAT data used is on initial planning for acquiring more data.

Brainstorming has produced four ASVT candidates. They are Forestry Management Co-Op, Insect and Disease Control Firm, Forest Fire Prediction Service, and Market Predictors Index of Wood Products.

1. Forestry Management Co-Op

A Forestry Management Co-Op is a cooperative of small woodlot owners applying data sources in a CGIS to answer their needs. There is no service of this type presently.

Table 13: Forest Management Information Needs

Tasks \ Data Needs	Cover Type Identification	Forest Location	Stand Area	Stand Size	Stand Composition	Stand Condition	Ownership Class	Amount Harvest	Stand Maturity	Site Index	Timber Volume Estimate	Stand Density	Location of Harvest	Successional Stages	Seed Source	# Seedlings Planted	Regeneration Potential	Use of Tree	Land Use Trends	Activity Spectrum	Travel Time
Forest Inventory	•	•	•	•	•	•	•	•	•	•	•	•	•	•							
Reforestation	•	•	•	•	•	•	•	•		•					•	•	•	•			
Private Forestry Improvement	•	•	•	•	•	•	•	•	•	•	•	•	•						•	•	
Harvest Scheduling and Method	•	•	•	•				•	•	•	•		•						•		•
Timber Stand Improvement	•	•	•	•	•	•	•	•	•	•	•	•									
Forest Conversion	•	•	•	•	•	•	•	•	•	•	•	•	•								
Disease and Pest Detection	•	•	•	•	•	•			•	•	•	•		•							
Fire Potential	•	•	•	•	•	•			•			•		•							•
Distinguish Forest Industry	•	•									•		•					•	•		
Run Nursery Program	•	•					•						•		•	•	•	•	•		
Fire Detection/ Fighting	•	•			•	•			•			•									•
Fire Damage Survey	•		•	•	•	•	•		•	•	•	•		•	•		•				
Land Capacity	•																				
Erosion Protection Plan																					
Soil Mositure Availability																					
Potential Cropping Scheme	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•						•
Soil Fertility Assessment	•																				
LANDSAT Applications (possible)	•	•	•	•	•	•		•	•		•	•	•						•	•	•

Tasks \ Data Needs	Recreational Use Intensity	Practice Required	Site Preparation Needs	Conversion Method	Slope	Aspect	Elevation	Amount of Fuel Build-Up	Location of Industry	Size of Industry	# Persons Employed	Presence of Air and Water Pollution	Type of Industry	Location of Fire	Wind Direction	Wind Speed	Humidity	Location of Firefighters	Size of Fire	Location of Rural Fire Protection District and Agreement	Time and Cause of Fire
Forest Inventory					•	•	•														
Reforestation							•														
Private Forestry Improvement																					
Harvest Scheduling and Method	•																				
Timber Stand Improvement	•	•	•																		
Forest Conversion				•																	
Disease and Pest Detection					•	•															
Fire Potential					•	•	•	•													
Distinguish Forest Industry					•		•		•	•	•	•	•								
Run Nursery Program					•	•	•														
Fire Detection/ Fighting					•	•		•						•	•	•	•	•	•	•	•
Fire Damage Survey			•		•		•	•						•					•		
Land Capacity																					
Erosion Protection Plan	•				•	•	•														
Soil Mositure Availability																					
Potential Cropping Scheme			•	•	•	•	•		•												
Soil Fertility Assessment					•	•	•														
LANDSAT Applications (possible)	•		•		•		•	•	•	•		•	•						•	•	

Tasks \ Data Needs	Degree of Damage	Texture Profile	Soil Location	Bulk Density	Porosity	Depth to Bedrock	Structure Profile	A-Horizon Thickness	Rate of Erosion	Type of Erosion	Soil Series Name or #	Consistence Profile	Macro-Nutrient Status	Micro-Nutrient Status	Cation Exchange Capacity	PH of Soil	Salt Content	Depth to Water	Organic Matter Content	Subsoil Color	Surface Color
Forest Inventory																					
Reforestation																					
Private Forestry Improvement																					
Harvest Scheduling and Method																					
Timber Stand Improvement																					
Forest Conversion																					
Disease and Pest Detection																					
Fire Potential																					
Distinguish Forest Industry																					
Run Nursery Program																					
Fire Detection/ Fighting																					
Fire Damage Survey	•																				
Land Capacity		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
Erosion Protection Plan		•	•	•	•	•	•	•	•	•	•									•	
Soil Mositure Availability		•	•	•	•							•						•			
Potential Cropping Scheme		•	•				•	•	•	•		•	•	•	•		•				
Soil Fertility Assessment		•	•	•			•	•			•		•	•	•	•	•				•
LANDSAT Applications (possible)	•	•		•	•		•		•	•				•					•		•

Woodlot owners have a profound effect on the wood market in the southern United States. Unfortunately, many woodlot owners abuse their holdings due to ignorance. The U.S. Forestry Service has tried to educate and provide information to owners with little success.[1] This service could educate and advise small woodlot holders to improve their profits and conserve natural resources.

The information needs vary from fundamentals of tree growth to present forest conditions. LANDSAT can supply information for target areas of service and some general information of forest conditions such as stand maturity and volume estimates. Information must be accurate and updated on the order of yearly.

In this area Comarc Corporation presently consults foresters with a CGIS system. Information and consulting they supply consists of site preparations, logging methods, forest inventory and environmental effects of logging. These consulting services are limited -- available only to large corporations, due to price. The costs would have to be small, or the large costs shared, for a service of this type to reach small owners.

The possibility of forest management through computers is being developed by Dr. Philip Dougherty at Weyerhauser. Presently, they are digitizing soil maps and location information. They hope to expand their data base for planning forests.

We plan more detailed investigation of costs, information processing, staffing, and market issues for this idea.

2. Insect and Disease Control Service

Insect and Disease Control Service, the second ASVT candidate, involves spotting forest vegetation stress through LANDSAT photos. Further information gathered through ground examination, combined in a CGIS, could

provide information for clients on a large regional basis. Methods of attacking and stopping the infested areas could be proposed by experts on the staff and monitoring could be continued by LANDSAT and other sources.

A report published by the USDA indicates that the technology for such a corporation exists. The report studies two areas, the Targehe and Blackhill National Forests.[2] Their sizes were 1,457,922 and 2,130,118 acres, respectively. The cost for Targehe was $3,000 and the Blackhills area cost $4,000. The cost is not prohibitive to identify problem areas and the cost would drop once an operating system was instituted. Information would have to be updated twice yearly.

A possible market area would be the southern United States. The northwest is not affected to the same degree and, therefore, might be a poorer market. This candidate business needs further investigation of prevention and extermination techniques as well as marketing issues and assessment of any present companies doing work in this field.

3. Forest Fire Prediction Service

The third candidate is a forest fire prediction service. Recent developments in predicting watershed content from snow fall and detection of dead trees in areas makes a service such as this possible. The purpose of forest fire prediction would be to warn timber owners of fuel build-up on their holdings and probability of moisture levels through the summers. Information on weather, geographic data of owners and others combined in a computer system could provide a quick forecast of forest conditions. The LANDSAT or other remotely sensed data would need to be timely. Users of such a service would include large land holders, the

Forest Service and owners of unattended woodlots. We have not initiated investigation of this idea. New information may revise the services suggested.

4. Market Predictor Index

The fourth application, a market predictor index, is a service geared for small purchasers of wood products and builders. This service would take national information on markets, forest resource variance, and sales practices and break the information down to regional levels. A publication sold semiannually or quarterly would relate the national information into regional data (using a CGIS) so that accurate forecasts could be made. Data such as LANDSAT would be required at least semi-annually. Costs would be large both for a staff of experts in forestry and economics and for the extensive data acquisition and processing.

Large corporations are beginning to develop systems like this one. International Paper Corporation is building a CGIS to determine and plan market decisions by monitoring other companies and small woodlots. Plans call for a LANDSAT coverage twice yearly of the southern region and aircraft reconnaissance as well. International hopes that this system can provide information on where to expand, how much to expand, what equipment is required, and when to cut lumber in certain regions. We were unable to ascertain system cost in an interview with them. Their hardware consists of a Comarc Resource Inventory System (CRIS). Building a system similar to this for a market forecast would be very expensive but maintenance and processing of data would be relatively inexpensive. Further research into users, developing a system, and cost is required to see if a project of this magnitude is feasible.

Investigations have revealed that there are many other applications for information systems in forestry. Research, at Purdue and the NASA Mississippi Center for example, is discovering new technological methods for applying remote sensing/CGIS's to forestry. Further investigation into the users of this data should reveal more ASVT candidates. Several other possibilities are volcanic effect and monitoring and pollution and hydrocarbon effects on forests.

An interview held recently with Dr. Chris Johannsen provided contacts in research and business as well as information on present research at the University of Missouri. Dr. Johannsen[3] also provided his views of LANDSAT's need to be linked witn geographical data bases. He emphasized the bright future of applications of LANDSAT for planning in forestry.

Further investigation of the aforementioned ideas will continue in economic and market analyses areas as well as a phone and questionnaire survey of the top ten U.S. forest firms. Information from research facilities is also being compiled to better our understanding of the capabilities of LANDSAT in this application.

Footnotes

1. Trude Foutch, "An Economic Analysis of Alternative Federal Incentives for Small Woodlot Management: Dent and Reynolds Counties, MO.," Dept. of Technology and Human Affairs, Washington University, St. Louis, MO., 1976.

2. Evaluation of a Commercial Geographical Data Base for Storage and Retrieval of Forest and Disease Information, USDA Forest Service, Report #79-4, May 1979.

3. Dr. Chris Johannsen, University of Missouri, Columbia, Missouri, personal interview, June 1980.

Task 6: Business Opportunities in Geology and the Mining Industry

Geological, mining, and energy related applications already benefit from LANDSAT data. The broad range covered by LANDSAT's MSS highlights large geological patterns. Oil companies buy about a third of the LANDSAT data sold by the EROS Data Center, a proportion far greater than for any other single user. Exploration for coal, uranium, copper, gold zinc, and silver use remote sensing to a lesser extent. One company, expressing the sentiment shared by many familiar with the mining industry, stated that technology in this field is twenty years behind the oil and gas industry. This lag is partly due to the cost of R&D. However, LANDSAT data use for fracture and fault detection is two thousand times cheaper than seismic methods and forty times less expensive than gama ray spectroscopy, so cost savings are an important motivation to the mining business to explore the use of LANDSAT. Most domestic land has been surveyed by conventional methods, but areas of inaccessibility can best be explored using remote sensing. Therefore there appears to be a strong potential market for LANDSAT in mining.

In addition to using remote sensing for exploration, identifying environmental effects associated with mining activities and the development of overall surface mining and reclamation techniques is another, perhaps more practical, application of remotely sensed data. Because it applies to existing mines, there is a potentially large domestic market. More than eighty minerals are surface mined in the U.S.[1], and stricter regulations on strip mine monitoring and reclamation may force miners to collect much more extensive information.

Remote sensing data is also helpful for the planning of transmission and pipeline corridors as well as siting studies for nuclear, fossil fuel, hydro, and waste disposal plants. Siting studies require indepth analysis, but satellite remote sensing plays a role in giving a broad first view and in filling gaps in existing data bases. Locating and assessing environmental impacts of these sites can utilize remote sensing.

Currently suppliers are using a variety of data to satisfy the needs of users in mineral resource applications. The sources of the data are: LANDSAT and other satellites; high and low altitude aircraft; manned spacecraft; slide looking airborne radar (SLAR); small scale, B&W and color infrared photographs; seismic data; topographic data; statistical sampling; magnetic and gravity surveys; radioactive surveys; stereo-imagery; and ground collected data. This data is most managable in a CGIS, and the majority of suppliers use some form of one. Digital LANDSAT data, subjected to various enhancement techniques, is especially useful.

A recent visit to the Earth and Planetary Sciences Imagery Center (funded by NASA and the McDonnell Center for Space Sciences) here on the Washington University campus showed us the type of computer system (hardware and software) and techniques that could be used by an entrepreneur in mining or geology. The Center's image processing hardware, which cost in the one hundred thousand dollar range, implements a wide range of image processing and enhancement techniques. With the exception of one full-time computer expert, staff are all geologists who have learned computer operations.

The Center visit showed us that: (1) after a good training program, geologist-users are fully capable of operating a LANDSAT processing

system/CGIS to serve their needs; (2) LANDSAT data are sufficiently timely for most geological and mining applications, and sufficiently accurate as well, in general (our own work[2] confirms this statement); and (3) processing systems for geological applications are relatively inexpensive. These three facts inspire our idea for an ASVT in this area.

We believe that a business which markets turnkey installations of image processing systems like the Center's -- designed specifically for geological applications and in the hundred thousand-dollar price range -- could be viable. There is a broad range of potential customers. A strip mining company could use the system for monitoring and perhaps, exploration.

There is also a large foreign market for cost-effective exploration techniques. Developing countries, especially, have a large amount of unexplored land. In addition, the system might be employed in planning electrical power transmission lines and oil and gas pipelines. Because of LANDSAT's ability to provide land cover and accessibility information along routes which can extend hundreds of miles, cost effective methods for depicting best access and most feasible corridors should be easily marketable in the developing world. On the other hand, systems for oil and gas exploration might not be a good idea for an ASVT because of the established market.

Our plans for further investigating these ideas are to review literature, interview, and survey potential users (such as mining companies) to find out their needs and then to investigate methodologies used to meet them today. We will then attempt to come up with business designs to provide marketable information products or turnkey systems.

Footnotes

1. A Study of Minerals Mining from the Perspective of the Surface Mining Control Act of 1977, National Academy of Sciences, Washington, D.C., 1977.

2. Eastwood, L. F., Jr., et. al., Earth Observation Data Management Systems, Final Report, Center for Development Technology, Washington University, St. Louis, Missouri, 1976.

PLANS FOR FUTURE ACTIVITIES

Details of our plans for further research appear at the ends of the discussions for Tasks 1 through 6. This section provides a brief overview.

The next major activity of our project will be to focus and refine our ideas for new businesses. Our goal is to choose three or four ideas from the many presented here for concentrated study. We have begun this process already; of our initial candidates, agribusiness, urban information systems, and consumer information have received the most attention. However, we are continuing to assess the forestry and mining industries, and a broad range of consumer products, so that we do not narrow our attention prematurely.

In those areas chosen for intensive analysis, we will continue our assessments already begun (or begin new ones) of customer needs and ability to pay, product design, business structure, predicted return on investment, etc. -- the key issues in designing a business. In addition, we will begin to relate these considerations to the design of an ASVT, an experimental business, in each area. In designing the experiment, we must consider its duration, levels of funding and staffing, skills and equipment needed as well as the parameters to be measured by the experiment.

We plan to meet in Washington with NASA officials to present the interim results and plans described in this report. The meeting should occur in July or early August, 1980.

APPENDIX A. NEWSPAPER ARTICLES ON THE PROJECT ON STIMULATING OPERATIONAL PRIVATE SECTOR USE OF EARTH OBSERVATION SATELLITE INFORMATION

WU Brainstorms Applications For NASA Satellite

The National Aeronautics and Space Administration (NASA) has named the WU Center for Development Technology the site of a year-long brainstorming session on LANDSAT, a remote sensing satellite which produces detailed images of the earth's surface.

Under a $100,000 contract from NASA's Office of Space and Terrestrial Applications, the Center will plan model programs to explore opportunities in remote sensing for private businesses.

"Our goal is officially termed 'technology transfer'," said Lester F. Eastwood, Jr., associate professor of technology and human affairs and principal investigator for the project. He pointed out that in the mid-1960s, NASA directed a similar transfer of communications satellite technology to private business.

Ideally, remote sensing data will be combined with aircraft imagery and existing statistics into computerized information packages. "The purpose of our project is to encourage 'information middlemen,' or entrepreneurs, to buy raw data and process it for specific customers," Eastwood explained.

He has identified several potential avenues of use for the information packages. A local government agency, for example, might want to determine which residential areas with a large older adult population are being taken over by commercial developers. By overlaying data bases on age, income and new building permits with remote sensing-derived data on residential and business districts, urban planners can quickly pinpoint, measure and study these areas.

Las Vegas, Nev., is shown surrounded by desert, snow-covered mountains and irrigated farmland in this computer image transmitted from a LANDSAT satellite. Superimposing population density data on this image, for instance, may yield information valuable to planners.

Similar applications of computerized information packages might be found for utility companies investigating new plant sites or commodity speculators surveying agricultural crops. Agribusiness, in fact, promises to be a prime candidate. According to Eastwood, authorities have used LANDSAT data to predict recent Soviet Union wheat crops with 99 percent accuracy months in advance of harvest.

Such predictions are possible because of LANDSAT's unique capabilities. Orbiting at a 500-mile altitude, the satellite can image some 13,000 square miles in 25 seconds. It observes the earth through both visible light and parts of the infrared spectrum, transmitting raw digital data which can be computer-processed to show different landcovers or enhance features such as geological patterns, water depth and turbidity, vegetation, slopes and soils.

The first LANDSAT satellite was launched in 1972. Two others have followed since then, each able to sense details as small as one acre. A fourth satellite, planned for launch aboard the NASA Space Shuttle, will relay images seven times sharper.

A number of image-processing companies have begun operations in the U.S., but most of their customers are in developing countries.

"I hope to get my best ideas from businesses that already exist," said Eastwood, who will be evaluating new applications, both domestic and foreign. He plans an extensive survey and is currently looking for WU graduate students interested in technology or business to assist with the project.

Washington University Record, February 7, 1980, p.2.

Center for Development Technology Gets NASA Grant

The National Aeronautics and Space Administration (NASA) has named the WU Center for Development Technology the site of a year-long brainstorming session on LANDSAT, a remote sensing satellite which produces detailed images of the earth's surface.

Under a $100,000 contract from NASA's Office of Space and Terrestrial Applications, the WU Center will plan model programs to explore opportunities in remote sensing for private business.

"Our goal is officially termed 'technology transfer,'" said Lester F. Eastwood, Jr., associate professor of technology and human affairs and principal investigator for the project. He pointed out that in the mid-1960s, NASA directed a similar transfer of communications satellite technology to private business.

Ideally, remote sensing data will be combined with aircraft imagery and existing statistics into computerized information packages. "The purpose of our project is to encourage 'information middlemen,' or entrepreneurs, to buy raw data and process it for specific customers," Eastwood explained.

He has identified several potential avenues of use for the information package. Among them are a local government agency's evaluation of urban growth patterns, a utility company's investigation of new plant sites, or commodity speculators' surveying agricultural crops.

Agribusiness, in fact, promises to be a prime candidate. According to Eastwood, authorities have used LANDSAT data to predict recent Soviet Union wheat crops with 99 percent accuracy months in advance of harvest.

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"I hope to get my best ideas from businesses that already exist," said Eastwood, who plans an extensive survey and will be evaluating new applications, both domestic and foreign.

Washington University Alumni News, Vol. 32, No. 1.

Prof. Eastwood Receives Research Contract From NASA

Lester F. Eastwood, associate professor of technology and human affairs, is the principal investigator for a project involving one of NASA's remote sensing satellites. The LANDSAT satellite transmits detailed images of the earth's surface back to space agency ground stations. Eastwood's project will evaluate new applications in business situations for the data received from the satellite.

The WU Center for Development Technology, partially funded by a $100,000 contract from NASA's Office of Space and Terrestrial Applications, will devise plans for NASA-funded experimental businesses that will extract information from remote sensing satellite data and sell it to customers involved in anything from urban planning to agribusiness.

Eastwood says that NASA terms the goal of the project "technology transfer," and he points out that it is similar to the transfer of communications satellite technology to private business directed by NASA in the 1960's. "LANDSAT isn't like the weather satellites whose market is basically just weather forecasters," says Eastwood. "Forestry, oil, agribusiness, land developers, and many other industries can use LANDSAT information."

Remote sensing data could be combined with aircraft imagery and statistics already in customers' files to form computerized information packages specialized for particular applications. For example, urban planning researchers can use satellite-derived land use data combined with census information to determine prospective sites for land development or to indicate where residential areas are being displaced by commercial developers. Oil companies can assess geologic features with the satellite-transmitted data. Agricultural businesses, however, may be able to derive the most benefit from the LANDSAT data, since the forestry industry can use the information to estimate timber yield, and crop forecasting can be conducted on the basis of remote sensing data.

The LANDSAT satellite in operation now, the third in a series begun in 1972, orbits at an altitude of 570 miles and can photograph approximately 13,000 square miles in 25 seconds. LANDSAT 4, planned for 1982, will be launched aboard the NASA Space Shuttle and will have the capability to take pictures with 7 times more detail than the present satellite.

Professor Eastwood will evaluate both foreign and domestic markets for the satellite data, hoping to identify new markets in a number of applications. "I hope to get my best ideas from businesses that already exist," Eastwood adds. He is looking for WU graduate students interested in technology or business to assist him in surveying potential markets and developing ideas for new businesses.

Washington University School of Engineering, Engineering Newsletter, Spring 1980, No. 36.

2E Thurs., March 13, 1980 ST. LOUIS POST-DISPATCH

NASA Pushing Earth Pictures

By United Press International

Orbiting 570 miles above the earth, the Landsat satellite covers the planet every 18 days, sending detailed images back to space agency ground stations.

Now the National Aeronautics and Space Administration wants to help private industry use these long-distance pictures for everything from urban planning to crop forecasting.

Lester F. Eastwood Jr., associate professor of technology and human affairs at Washington University, heads a team working under a $100,000 grant to propose commercial uses for the satellite maps. He says NASA is willing to take the initial risk to start the industry growing.

"The government doesn't want to compete with private enterprise," Eastwood said in an interview. "That would be unfair competition. But it does want to stimulate the industry, and it hopes this is the best way.

"NASA wants to demonstrate the capability of the Landsat technology, then step aside and let private business take over."

Eastwood compared the current situation to the transfer of communications satellite technology to private enterprise in the 1960s, a transfer that led to a revolution in the communications industry. And then, he said, the applications were obvious and the companies involved were already giants in the field.

Now, Eastwood said, the technology exists, but the applications and the industries to use them are not so well established.

"We can't answer yet whether this is commercially viable. You don't need a satellite to map land use. You can drive around in a pickup truck and do it. It's more expensive to do it with a pickup truck, but the traditional methods still compete."

Eastwood has worked since 1975 helping state and local governments find uses for the Landsat pictures. Combining the satellite information with data from other sources can bring many kinds of results, he said.

"A planner may ask which areas in St. Louis County are changing from residential to commercial and have a population over 65 that earns $5,000 a year," he said.

"To find out where old, poor people are being displaced, you can use the computer to combine census information and land-use information. Similarly, the computer can overlay three types of information and give prospective sites for development, which can then be inspected personally."

Forestry companies can use the data for timber estimates, he said, while oil companies can use the pictures to determine certain land conditions. Eastwood said authorities using Landsat data predicted recent Soviet wheat harvests months in advance with a 99 percent degree of accuracy.

The first Landsat satellite was launched in 1972. The third in the series is operating now, and a 1982 date is forecast for Landsat 4, which will take pictures with seven times more detail.

About 200 companies use the pictures now, Eastwood said, and the government wants to ensure that the data can be used as widely and as efficiently as possible. "This isn't like a weather satellite, where your market is basically just weather forecasters," he said. "With Landsat, you have forestry, oil, agribusiness and a whole range of industries which can use this information.

"The government has been wrestling with the problem of how to make this sy[illegible] operate like the weather satellite operates. Th[illegible] want to sell the products on a regular basis to a wide variety of customers.

"Developing new markets is a costly and risky thing to do, and existing industries naturally move toward areas which are most likely to pay off quickly."

Business Of Using

By Robert Sanford
Of the Post-Dispatch Staff

WHEN the cotton bollworm threatened some cotton fields in California, it was watched by use of a space satellite, and the insect invasion was stopped.

The screwworm is a destroyer of cattle and poultry in Mexico. Satellite surveys gave information for proper timing in combating the insect's growth.

Space photography helped map a battle line in Central America against the Mediterranean fruit fly, the most destructive fruit pest worldwide.

There are satellite image techniques to tell ranchers when and where to graze their stock, to tell farmers what kind of chemicals (herbicides, pesticides, fertilizers) are needed, to tell foresters where stands of hardwood and pine are located.

The uses of satellite images increase. Unreclaimed, strip-mined land was revealed in Maryland, where a law requires reclamation. Space photography even foiled an old scam of Florida land promoters — selling home lots that were under water.

What new uses are likely? That is a question that occupies Lester F. Eastwood Jr., associate professor of technology and human affairs at Washington University. Eastwood and research associates have an assignment from the National Aeronautics and Space Administration to consider new uses for Landsat, a satellite system that gives detailed images of the earth's surface.

Through efforts of Eastwood and others, the Center for Development Technology at Washington U. has a $100,000 contract with NASA to brainstorm new satellite uses. An objective is to make satellite information a saleable item that has a market value and is helpful in the business world.

The Landsat system has three satellites aloft, and another one is schedulld to be launched in orbit by the Space Shuttle in a year or two. A Landsat satellite orbits the earth at a 500-mile-high altitude and can scan 13,000 square miles in 25 seconds. It looks at the earth both through visible light and through parts of the infrared spectrum, sending this information back as raw digits which then must be interpreted by a computer that assembles them into a picture, adding form and color.

What NASA would like to do is find out how these pictures can best serve the day-to-day business of the country. Several years ago, there were a number of firms eager to invest in the use of communications satellites. Their use is routine today in public consumption (television, telephones), as is the use of weather satellites.

But for the Landsat images of the earth's surface the market is not so easily defined. So NASA, through the Washington U. project and others, is giving the matter some thought. What good are images of the land's surface from a viewpoint of 500 miles up?

"Well, for one thing," a satellite worker said, "the distance helps one see the forest instead of the trees."

The successful use of land depends a lot on water, of course. The lush, green cornfields of Nebraska owe a lot of their crop growth to irrigation water brought up from wells. But there is danger in too much irrigation. As more water is pumped out of wells and the ground's water reserve is lowered the pumps may bring mineralized, salty water to the surface. As a guard against too much irrigation, Nebraska has used Landsat images to monitor the number of irrigated plots. Such an inventory of water use becomes more important in areas to the west where rainfall is lower.

Missouri does not escape such concerns about water supply. A few years ago, in a drought period, some indications of mineralized water were found in wells in central and southwestern parts of the state. The question was posed as to whether the underground water supply was being lowered because increasing amounts of surface water were being impounded in newly built ponds. The Washington U. group suggested that Landsat offered a quick, inexpensive way to survey the number of new dams and ponds.

Two years ago, the Washington U. group did a planning study for NASA of ways to go about setting up a natural resources information center for the state of Missouri that would combine satellite picture images with other "file cabinet" information on hand. The proposal for a Missouri center didn't get past the planning stage, but a number of states do use Landsat images in various ways in planning for land use, water use, forestry management and wildlife habitat.

CHALLENGES science

Some simply buy pictures from the Earth Resources Observation Systems (EROS) Data Center at Sioux Falls, S.D., where the information is for sale at a nominal price. Half a dozen states have computer systems that can assemble images from raw data.

A question that comes up often in the use of technological data is how to slice it — how to display it so that it is readable and understandable. With a basic map image as a start, more information can be added with transparent overlays. The result is an information sandwich.

On a map image of a city, information can be added, say, to show what areas are occupied mostly by elderly people and whether they are being driven out by commercial development. In outlying areas, the imagery can indicate good industrial building sites — areas with low slope, little forest cover, easy access to railway lines and whether proper zoning laws exist for development. The accessability of water, its turbidity and land erosion patterns can be

(con't on p.

Satellite Photography

Courtesy of the Environmental Research Institute of Michigan

The small light-blue areas in this false-color Landsat image of Washington's Olympic Peninsula are once-forested areas that have been clear-cut—an example of the way satellite imagery can be used to keep track of natural resources. This view also shows snow-capped mountains, dark-red coniferous forests and lighter-red stands of deciduous trees. The large light blue area at left is a cloud over the darker Pacific.

displayed through satellite images.

The new Landsat that is going up in the future will be much more precise than the current satellites. The Washington U. group was consulted on its design. Where early Landsats depicted areas of an acre in size, the new one will be seven times more accurate.

"Landsat images made it possible for observers to predict Soviet wheat production months ahead with 99 percent accuracy," Eastwood said. "But prediction of crops in the U.S. or India, say, was not as accurate because the fields are smaller. The new satellite will allow more accurate predictions."

Oil companies have been big users of satellite pictures, Eastwood said, because the images may suggest the presence of oil in the vicinity of known oil fields. Because the satellite information is useful in several fields — agriculture, forestry, water use, oil — some companies have been set up that process the data and sell it. Part of Eastwood's assignment, along with Katherine Warner, research associate, is to suggest three new companies that would deal in satellite information. If the suggestion was accepted, NASA would set up the companies with a goal of allowing them to be absorbed into the commercial market, thus lessening the role of the government.

"Our goal is officially termed 'technology transfer,'" Eastwood said. "The field seems to offer opportunities for new businesses to form. Weather satellites brought improved information to the public by way of forecasts. Improved forecasting of crops and livestock production could bring more timely information to the consumer.

"Maybe in the future, the weather man on television will have a new companion, the 'agriculture man,' who will give advice as to good times to buy certain kinds of food."

APPENDIX B. MATERIALS RELATING TO THE INDUSTRY SURVEY

<u>Contents</u>:

1. Initial Survey Letter
2. Sample Telephone Interview Form
3. Project Mailing List

WASHINGTON UNIVERSITY IN ST. LOUIS

Center For
Development Technology

I am a research associate at Washington University, St. Louis, involved in a NASA-sponsored study of private companies and institutes that provide remote sensing and geobased information system services, products, and equipment. In surveying the industry, we are concerned with the following questions:

1. What types of remote sensing services and products is the industry supplying to private sector, public sector, and foreign customers?

2. Which application areas and customers does the industry serve?

3. What do the services and products cost?

4. Are there new services, presently too risky for the private sector to provide, which government experiments could usefully test?

Any promotional materials, annual reports, or user needs studies, that pertain to the first three questions or describe your services would be helpful to our research. If you have suggestions or opinions about the fourth question, they too would be most useful. Thank you for your assistance and consideration.

Sincerely,

Katherine Warner

Katherine Warner

KW:dbw

Washington University
Campus Box 1106
St. Louis, Missouri 63130
(314) 889-5455

Company Name: *Ecographics Int'l Env. Analy.* Contact Person: *Ralph Brown*

Address: *P. O. Box 706* Title: ______

LaJolla, CA. 92038

Phone Number: *(714) 226-1259*

1. SOURCES OF DATA: % of Total Data Base

x a. Satellite (Landsat) *CCT's* *90%*

x b. Hi-altitude A/C (65K feet, Color IR) *U-2* ______

x c. Lo-altitude A/C (25-6K feet, B&W or Color IR) *as required* ______

x d. Ground survey by company *do it themselves* ______

___ e. Customer's files ______

2. APPLICATION AREAS: *Specialize in Ecological Applications* Notes on Application Areas

a. agricultural production and services ______

b. environmental impact ______

c. forestry and forest services ______

d. geography and mapping ______

e. geology - *mineral exploration (just starting)* ______

x f. metal mining ______

g. oil and gas exploration ______

h. range management *wildlife reserve planning, wildlife habitat analysis vary biotic data w/abiotic data, high desert, creating geo-based info system.*

i. real estate, urban planning ______

j. transportation planning ______

k. utilities (gas and electric) ______

l. water resources management ______

m. other *resource inventories* ______

3. GEOGRAPHIC AREAS: — Notes on Application Areas

x a. Far West (AK, HA, CA, OR, WA, NV) — high desert

___ b. Rocky Mountain (MT, ID, WY, CO, UT)

___ c. Southwest (AZ, NM, OK, TX)

___ d. Plains (ND, SD, NB, KA, MN, IA, MO)

___ e. Great Lakes (WI, MH, IL, IN, OH)

___ f. Southeast (AR, LA, KT, TN, MI, AL, WVa, VA, NC, SC, GA, FL)

x g. Mideast (NY, PA, NJ, DL, MD) — naval base location

___ h. New England (MA, VT, NH, CT, RI, MA.

x i. Foreign Mexico

4. PRODUCTS: — Price

___ a. reports — standardized or regularily updated

x b. reports -- specialized or one-shot

___ c. tables

x d. maps 1:24,000, 1:250,000

___ e. hardware no, time share

- ___ full computer processing system hardward and software)
- ___ components
- ___ manual photointerpretation equipment

___ f. software - CVOS programming

- ___ remote sensing classification package
- ___ CGIS software package
- x flexible to do any

5. SERVICES: — Price

x a. consulting in application areas resource inventories

x b. consulting in remote sensing Workshops in San Diego
- to see potential
- attended by government types
- pick up basic skills.

5. SERVICES: (continued) — Price

___ c. teaching ___

___ d. data processing ___

x geometric/radiometric correction pre-processing — *have gotton some not in raw form* ___

x classification (processing) ___

x computerized geographic information system (data base management) — *(developed one before - in process of developing others)*

x e. data gathering ___

x ground surveys ___

x aerial surveys ___

6. CUSTOMERS — Notes on Product or Application

a. private sector:

EG&G Analytical	*Navel base on Patomic River*
Kelco	*harvest kelp, for emulsifiers*

b. public sector:

Marine Corp	*high desert*
Audobon Society	*investigate condor habitat*

c. foreign customers:

Mexico	

6. HOW DO YOUR CUSTOMERS FIND OUT ABOUT YOUR PRODUCTS, SERVICES?

Notes on P.R., Advertising

mostly word of mouth
co. defined user needs

developed proposals

___ a. trade journals ____________

___ b. conferences ____________

___ c. promotional materials (mail outs, ads) ____________

___ d. direct contact ____________

___ e. information and referral agencies (e.g. NASA, TAC, etc.) ____________

___ f. other ____________
little response from mail ads.

7. Do you have any ideas for products or services that are too expensive or risky to be developed at the present time? If NASA proved the feasibility of these ideas, would you try to market them?

Small user - unaware what is available

frightened about big comp.

Gov't - political restraints of ecosystems.

Private co. can extend past political boundaries.

8. NOTES:

Wanted to have own satellite in California: 6 million, but Prop. 13 made not feasible.

Targeting small user:

- *can't afford overhead*
  - *Ecosystem has low overhead*
  - *puts together team for different application areas*
  - *low overhead important*

Government involvement

- *not too much competition*
- *made more visible uses of remote sensing*
- *implement own programs*
  - *still so many more applications*
  - *states more interested in own boundaries.*

PROJECT MAILING LIST

ABRAMS AERO SERVICES
Mr. James Linn
Abrams Aero Services
P. O. Box 15008
Lansing, MI 48901

AERONEUTRONICS FORD
Mr. Norman Hines
Director, Earth Resources
Aeroneutronics Ford
1002 Gemini Avenue
Houston, TX 77058

ANALYTIC PRODUCTS INCORPORATED
Mr. Matthew J. Barrett
President
Analytic Products Incorporated
5614 Alta Vista Road
Bethesda, MD 20034

ARTHUR D. LITTLE, INC.
LeRoy Stewart
Arthur D. Little, Inc.
Acorn Park
Cambridge, MA 02140

AVCO
J. A. Proodian
AVCO
2385 River Beach Pkwy
Everett, MA 02149

AYDIN CORPORATION
Mr. Kenneth Nelson
Director of Corporate Marketing
Aydin Corporation
475 L'Enfant Plaza, SW
Suite 2970
Washington, DC 20024

CALSTAN CORPORATION
John Walker
Calstan Corp.
P. O. Box 400
Buffalo, NY 14225

COMMONWEALTH ASSOCIATES
Mr. Steven Fitzroy
Commonwealth Associates
209 E. Washington Avenue
Jackson, MI 49201

COMPUTER SCIENCE CORPORATION
Richard D. Brown
K. C. Leung
Computer Sciences Corp.
8728 Colesville Rd.
Silver Spring, MD 02910

COMSAT GENERAL CORPORATION
Paul Maughan
COMSAT General Corp.
950 L'Enfant Plaza, SW
Washington, DC 20024

DAEDALUS ENTERPRISES
Mr. Thomas R. Ory
Director of Applications
Daedalus Enterprises
P. O. Box 1862
Ann Arbor, MI 48106

DAMES AND MOORE
Mr. J. Spencer Houston
Director, Earth Resources
Dames and Moore
6 Commerce Drive
Cranford, NJ 07017

Yolanta Jonynas
Dames and Moore
Suite 700
7101 Wisconsin Avenue
Bethesda, MD 20770

DATATRONICS
Mr. Robert Corbey
Marketing Manager
Datatronics
11440 Isaac Newton Square North
Reston, VA 22090

PROJECT MAILING LIST (cont.)

DBA SYSTEMS INC.
Mr. John Dugan
DBA Systems Inc.
200 Beltway Building
Suite 200
9301 Annapolis Road
Lanham, MD 20801

DICOMED
Mr. Wayne R. Huelskoetter
Vice President
DICOMED
9700 Newton Avenue South
Minneapolis, MN 55431

DIGITAL IMAGE SYSTEMS DIVISION
Mr. Leo Eichen
Technical Consultant
Digital Image Systems Division
Control Data Corporation
2800 East Old Shakopee Road
P. O. Box 1249
Minneapolis, MN 55440

EARTHSAT
Mr. J. Robert Porter
President
EarthSat
7222 47th Street (Chevy Chase)
Washington, DC 20015

Dr. Charles Sheffield
Vice President
EarthSat Corporation
7222 47th Street
Washington, DC 20015

EBASCO SERVICES
Barry Siegal
EBASCO Services
2211 W. Meadowview Rd.
Greensboro, NC 27407

ECOSYSTEMS INTERNATIONAL, INC.
Mr. Peter A. Castruccio
President
Ecosystems International, Inc.
P. O. Box 225
Cambrills, MD 21054

EG&G/WOLF R&D
George Nesterczuk
EG&E/Wolf R&D
6801 Kenilworth Avenue
Riverdale, MD 20840

EMERSON ELECTRIC COMPANY
Mr. C. G. Kretschmer, III
Consultant
Rantec Division
Emerson Electric Company
Suite 1000
2361 South Jefferson Davis Hgwy
Arlington, VA 22202

ENVIROSPHERE, DIVISION OF EBASCO SERVICES, INC.
Mr. W. D. Patterson
Envirosphere, Division of Ebasco Services, Inc.
19 Rector Street
Room 300
New York, NY 10006

ESL INC.
Richard Kroeck
ESL Inc.
495 Java Drive
Sunnyvale, CA 94086

EXOTECH, INC.
Mr. Robert Sadler
Exotech, Inc.
1200 Quince Orchard Boulevard
Gaithersburg, MD 01760

FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
Mr. T. Palamenghi
Imaging Systems Division
Fairchild Camera and Instrument Corporation
Space & Defense Systems Div.
300 Robbins Lane
Syosset, Long Island, NY 11791

PROJECT MAILING LIST (cont.)

FAIRCHILD SPACE AND ELECTRONICS COMPANY
Mr. Mort Cohen
Fairchild Space and Electronics Company
20301 Century Boulevard
Germantown, MD 20767

GEOSPACE
Mr. Patrick Condren
Geospace
5803 Glenmont Drive
Houston, TX 77036

GEOSPECTRA
Mr. Robert K. Vincent
President
Geospectra
P.O. Box 2077
Ann Arbor, MI 48103

GRAPHICS
Dr. Thomas Balcerak
Graphics
2712 Middleburg Drive
Suite 101
Columbia, SC 29204

GRUMMAN ECOSYSTEMS CORPORATION
Mr. Douglas Hill
Grumman Ecosystems Corporation
Bethpage
Long Island, NY 11714

HALBOUTY CENTER
Mr. Michael T. Halbouty
Consulting Geologist and Petroleum Engineer
Halbouty Center
5100 Westheimer Road
Houston, TX 77056

HOWARD, NEEDLES, TAMMER, AND BERGENDOFF
Mr. Charles F. Zirzow
Howard, Needles, Tammen, and Bergendoff
1500 North Beauregard
Alexandria, VA 22311

HRB SINGER
Phil Cassara
HRB Singer
P. O. Box 60
State College, PA 16801

Mr. Donald Kirsch
Director of Marketing
HRB Singer
P. O. Box 60
Science Park
State College, PA 16801

IBM
Mr. Charles D. Gilmore
Senior Marketing Administrator, IBM
P. O. Box 1369
Houston, TX 77001

INSTITUTE FOR ADVANCED COMPUTATIONS
Mr. R. Michael Hord
Program Support Representative
Institute for Advanced Computation
128 South Royal Street
Alexandria, VA 22314

INTERPRETATION SYSTEMS, INC.
Mr. Jerry Lent
Director of Image Analysis
Interpretation Systems, Inc.
P. O. Box 1007
Lawrence, KS 66044

ITEK CORPORATION
Mr. Ronald Ondrejka
Itek Corporation
Optical Systems Division
10 Maguire Road
Lexington, MA 01824

William Williamson
ITEK Corporation
1901 N. Moore Street
Arlington, VA 22209

PROJECT MAILING LIST (cont.)

JDB AND COMPANY

Thomas Bolle
JDB and Company
1629 K Street, NW
Wuite 700
Washington, DC 20007

Carlos Schidlowski
JDB and Company
1629 K Street, NW
Suite 700
Washington, DC 20007

JET PROPULSION LABORATORY

Dr. Ray J. Wall
MS 168-417/Space Image Processing
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91103

KOOGLE AND PAULS ENGINEERING, INC.

Mr. Basil Pauls
President
Koogle and Pauls Engineering, Inc.
8338A Comanche, Northeast
Albuquerque, NM 87110

KUCERA AND ASSOCIATES

Mr. John W. Antalovich
President
Kucera and Associates
7000 Reynolds Road
Mentor, OH 44060

LOCKHEED ELECTRONICS

Mr. K. E. Bentley
Director of Science and Applications
Services and Systems Division
Lockheed Electronics
16811 El Camino Road
Houston, TX 77058

MAJOWER ASSOCIATES

Mr. Herbert Majower
President
Majower Associates
11736 Lovejoy Street
Silver Spring, MD 20902

MARTIN MARIETTA AEROSPACE CO.

James Gliozzi
Martin Marietta Aerospace Co.
P. O. Box 179
Denver, CO 80202

Mr. Sidney Russak
Martin Arietta Aerospace Co.
P. O. Box 179
MS0202
Denver, CO 80201

MEAD TECHNOLOGY LABORATORIES

Dr. T. L. Loucks
President
Mead Technology Laboratories
3481 Dayton-Xenia Road
Dayton, OH 45432

METRICS, INC.

Mr. G. William Spann
Vice President
Management and Engineering Consulting
Metrics, Inc.
290 Interstate North
Suite 116
Atlanta, GA 30339

NRC - SPACE APPLICATIONS BOARD

Laurence Gilchrist
NRC - Space Applications Board
2101 Constitution Avenue, NW
Washington, DC 20418

OKLAHOMA FOUNDATION

Mr. James Dawson
Oklahoma Foundation
2100 S. Broadway
Edmond, OK 73034

OPTRONICS INTERNATIONAL, INC.

Mr. Michael Bryant
Optronics International, Inc.
7 Stuart Road
Chelmsford, MA 30406

PROJECT MAILING LIST (cont.)

PHOENIX CORPORATION
Robert Regan
Phoenix Corporation
1600 Anderson Road
McLean, VA 22102

PUBLIC TECHNOLOGY, INC.
Ned Buchman
Public Technology, Inc.
1140 Connecticut Avenue, NW
Washington, DC 20036

Mr. Joseph M. Carlson
Assistant to the Senior Vice President
Public Technology, Inc.
1140 Connecticut Avenue, NW
Washington, DC 20036

RAMIS, INC.
Bob Foulk
Ramis, Inc.
3896 Sunset Road
Santa Barbara, CA 93110

RCA
Anthony Bartuska
RCA Front and Cooper Sts.
Camden, NJ 08102

Mr. E. A. Stillwell
RCA
Governmental Commercial Systems
Market Administration
Morristown, NJ 03057

RESOURCES DEVELOPMENT ASSOCIATES
Sybil S. Barefoot
Resources Development Associates
1101 N. San Antonio Road
Mountain View, CA 94043

Mr. Kenneth Craib
Resources Development Associates
P. O. Box 239
Los Altos, CA 94022

SCIENCE APPLICATIONS, INC.
Dr. Michael Griggs
Science Applications, Inc.
P. O. Box 2351
LaJolla, CA 92037

SEISCOM DELTA, INC.
Mr. Howard Brister
Manager
Digital Images Division
Seiscom Delta, Inc.
P. O. Box 36928
Houston, TX 77036

SPACE DIVISION
Mr. Daniel Fink
Vice President and General Manager
Space Division
P. O. Box 8555
Philadelphia, PA 19101

SPECTRAL DATA CORPORATION
Mr. William Smith
Spectral Data Corporation
1500 Wilson Boulevard
Suite 317
Arlington, VA 33309

TEAM INTERNATIONAL
Mr. Charles Rudder
President
Team International
1100 Quail
Newport Beach, VA 92660

TELEDYNE GEOTRONICS
Mr. Louis A. Woodward
Teledyne Geotronics
725 East Third Street
Long Beach, CA 90182

TEXAS INSTRUMENT CORPORATION
Mr. William Lancaster
Texas Instrument Corporation
Geophysical Services Group
13500 North Central Expressway
P. O. Box 5621
Dallas, TX 75222

C-2

PROJECT MAILING LIST (cont.)

TROLLINGER GEOLOGICAL ASSOC., INC.
Mr. W. V. Trollinger
President
Trollinger Geological Associates, Inc.
2150 S. Bellaire Street
Denver, CO 80222

TRW - DSSG
Richard W. Silva
TRW-DSSG
2030 M Street, NW
Washington, DC 20036

TRW SYSTEMS GROUP
Mr. George Solomon
Vice President
TRW Systems Group
One Space Park
Redondo Beach, CA 90277

UNIVERSITY CITY SCIENCE CENTER
Huston McIlvain, Jr.
University City Science Center
3624 Science Center
Philadelphia, PA 19104

Mr. Don H. Overly
Director
Washington Programs
University City Science Center
1717 Massachusetts Avenue, NW
Suite 707
Washington, DC 20036

UTILITY DATA CORPORATION
Mr. Robert W. Thompson
Vice President
Utility Data Corporatin
4263 Dacoma Street
Houston, TX 77018

C-2

Appendix C:

Methodology - Jack Huisinga: Private Sector Short-term Grain Information Needs and Potential Delivery Technologies.

The agri-business community was divided into eight industry groups (see Table 2) such as equipment manufacturers, chemical manufacturers, grain traders, etc. Note farmers were excluded from the survey. Experts were consulted, literature pertaining to the subject reviewed, and a questionnaire was developed and distributed to "agriculturally related firms which may have an interest in grain information."[3]

The survey was mailed to 156 firms. The response rate was 32%, not including 14 which were returned blank (the firms stated they had little or no need for crop information). Samples thus derived were in most cases not representative of the population and were in fact purposely biased toward larger firms by the means of selection, as it was assumed larger firms would be in a better position to make use of remote-sensing-derived information.

The questionnaire itself was designed to optimize information gathering potential in as compact a form as possible. Thirteen multiple response questions were structured such that responses to previous questions did not bias responses to later questions. The last four questions were more open-ended inviting any level of detail in the response the respondent cared to provide. The subjects covered included firm characteristics, unsatisfied information needs, desired temporal characteristics of provided information, desired form of presentation of information, the firm's current information sources, the use made of the information by the firm (extraction and interpretation), current expenditures for information,

likelihood that the firm would purchase information if it could be provided at less cost by a private firm, and how much the firm would be willing to pay for each information (a range).

APPENDIX D. DETAILS OF THE MUNICIPAL PLANNING INFORMATION SYSTEM INVESTIGATION

A. INTRODUCTION

This appendix reviews one project member's investigation of the possibility of developing an urban information system by merging the St. Louis County data base on residential structures with the U.S. Census's DIME files to form a geocoded data base of municipal data.

B. BACKGROUND

1. The DIME File

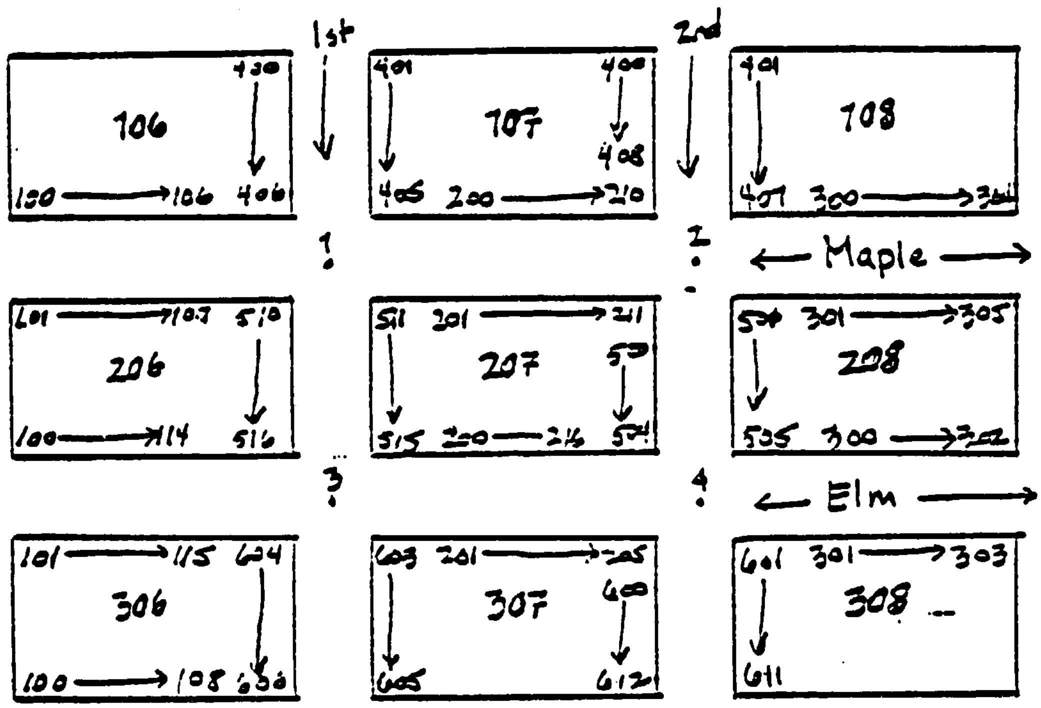
The DIME file is the result of using the Dual Independent Map Encoding (DIME) process to form computer readable maps. Essentially, the DIME process converts maps from their familiar graphic form to a computer-readable format. The DIME file is the accumulation of records which contain data on each street segment within a Standard Metropolitan Statistical Area (SMSA). The illustration in Figure 1 will be used to clarify what is contained in each record.

In the DIME process, a graphic map similar to the one in Figure 1 is converted to a series of nodes and street segments. Blocks are numbered by their respective census block number. Normally the intersection of two streets is defined as a node and the distance between two nodes as a street segment. In Figure 1, the portion of Maple between nodes 1 and 2 is a street segment. Each record of the DIME file is a description

Figure 1

Sample Geographic Map Used

for DIME File Coding



of individual street segments. Following in our example, to describe the street segment of Maple from node 1 to node 2, one would stand at node 1 facing node 2. On the right side would be block number 204 with the addresses ranging from 201-211. On the left, would be block number 107 with the addresses ranging from 200-210. In addition, it would be important to know within what zip-code, ward, and census tract the street segment is located. This is exactly the data in each DIME file record. In Figure 2, an example of a DIME file record is shown. Figure 2a is the information which is specific to the street segment and Figure 2b is information about the surrounding area. This process is continued with all the nodes being connected with one another, until the file is built. There are approximately 60,000 DIME file records for all the St. Louis County street segments.

These street segment descriptions are also geocoded, meaning that the nodes which define the end points of the segment are given an X-Y coordinate. Usually this is the latitude and longitude of the node. These grid coordinates are attached to each street segment record. By having the coordinates of the nodes, the street segment can be accurately reproduced on a computer generated map. Such a computer generated map for University City, Missouri is shown in

Figure 2

Sample of Information Within

A DIME File Record

Segment name or description	Code	From node	To node	Block No.		Left Addresses		Right Addresses		Header No.
				Left	Right	Low	High	Low	High	
ANDERSON RD.		75	76	111	120	900	998	901	999	20151
ANDERSON RD.		76	77	112	119	1000	1098	1001	1099	20151
ANDERSON RD.		77	78	113	118	1100	1198	1101	1199	20151
ANDERSON RD.		78	79	114	117	1200	1248	1201	1249	20151
ARGONNE ST.		34	36	271	279	400	448	401	449	20151
ARGONNE ST.		36	35	270	283	450	498	451	499	20151
ARGONNE ST.		35	39	270	282	500	598	501	599	20151
BADGER RIVER	2	107	108	137	137					20151
BADGER RIVER	2	108	112	137	137					20151
BADGER RIVER	2	112	113	138	137					20151

a.) Description of a DIME Street Segment.

ZIP code	Area Code		Ward		Census tract		Header No.
	Left	Right	Left	Right	Left	Right	
11001	25	25	7	7	14	15	20151

b.) Description of the Area Surrounding the Street Segment.

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Figure 2

Sample of Information Within

A DIME File Record

Segment name or designation	Code	From node	To node	Block No. Left	Block No. Right	Left Addresses Low	Left Addresses High	Right Addresses Low	Right Addresses High	Header No.
ANDERSON RD.		75	76	111	120	900	998	901	999	20151
ANDERSON RD.		76	77	112	119	1000	1098	1001	1099	20151
ANDERSON RD.		77	78	113	118	1100	1198	1101	1199	20151
ANDERSON RD.		78	79	114	117	1200	1248	1201	1249	20151
ARGONNE ST.		24	26	271	279	400	448	401	449	20151
ARGONNE ST.		26	25	270	283	450	498	451	499	20151
ARGONNE ST.		25	29	270	282	500	598	501	599	20151
BADGER RIVER	2	107	108	137	137					20151
BADGER RIVER	2	108	112	137	137					20151
BADGER RIVER	2	112	113	128	137					20151

a.) Description of a DIME Street Segment.

ZIP code	Area Code Left	Area Code Right	Ward Left	Ward Right	Census tract Left	Census tract Right	Header No.
11001	23	25	7	7	14	15	20151

b.) Description of the Area Surrounding the Street Segment.

Figure 3. The result is that a standard geographic map which includes the range of addresses for each block face is converted into a computer readable format which can be used to reproduce the geographic map that was its source.

2. NICKLE File

The DIME file can also be split to form a NICKEL file which is much more useful when merging the DIME file with another database. One DIME file record is split to made two NICKEL file records. Each NICKEL record contains data for one side of the street of a DIME file record. As the name implies, it is a split of the DIME file. The most important feature of the NICKEL file is the linking of the NICKEL file geocodes to local data that is address referenced. This is the essence of the merging process.

3. The ADMATCH Process

The local data that this project intends to merge with the DIME file is the data St. Louis County collects for each parcel of land within the County. A parcel is defined as any tract of land that has a unique address associated with it. There are approximately 300,000 parcels within the County. The County maintains a great deal of information about each parcel, and the exact content of this information will be provided in the later section of documenting the

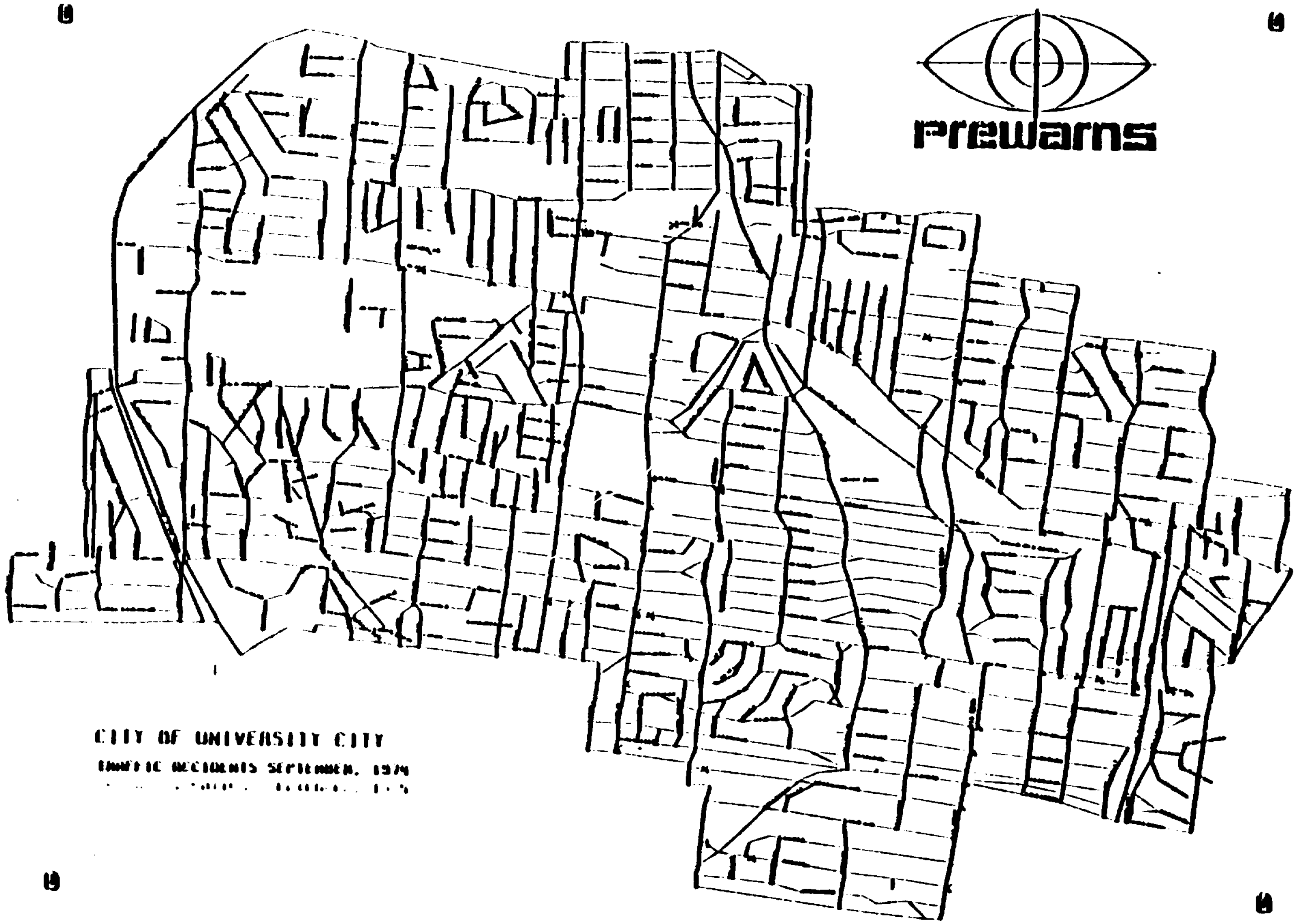


Figure 3. Computer Generated Map of University City, Missouri.

St. Louis County data base. Through the merging process to form the St. Louis County Information Data Base, it is hoped that this information can be aggregated and provided to the public.

Each parcel of land for which the County maintains records has an associated address. The intention of the merging process is to take each individual County record address and find the associated NICKEL file street segment record. This can be done as the street segment record has the range of addresses on one side of a street segment. Once the match is found, the geocode from the NICKEL file record is attached to the County record and a new record is formed. This new record contains data specific to that address such as type of structure, age of the structure, land use etc., but also is geocoded with the X-Y coordinates of the nodes that define its unique street segment.

The merging process that was described in the previous paragraph can be done by a program that is provided by the Census Bureau called ADMATCH. ADMATCH is a very sophisticated data manipulation program which takes local addresses and finds the associated NICKEL record, and attaches the geocodes of the nodes defining the street segment. The new geocoded records are accumulated to form the St. Louis General Information Data Base.

With local data in this form it is very easy to aggregate the data to any geographic level desired. The aggregation will be demonstrated using Figure 4. Through the ADMATCH process, the information that the County has, as discussed in the previously, for address 201 Maple will be given a geocode from the matching NICKEL record. This geocode would place this information specific to address 201 Maple exactly along the street segment between nodes 1 and 2 on block number 205. The information about the other addresses would be linked exactly in this manner. It can be seen that by knowing the nodes at each end of a street segment, data concerning the addresses along the side of a block can be grouped together and in this form, the common information for all the addresses can be accumulated or aggregated. This principal can be extended to higher levels of aggregation.

It is the intention of the project between the County and UMSL to provide just this type of aggregated information to interested parties. Files will also be maintained of past aggregations, such that time trends in the data may be observed. The flow chart in Figure 5 shows the steps involved in developing the St. Louis County General Database. The first step necessary towards completion of the project was to document the contents of the St. Louis County Data Base. From there, the NICKEL file and the County Data Base

could be merged to form the General Information Data Base. Public input, in the form of requests for particular types of data were necessary to determine what should be offered to the public. It was hoped that this information could be provided in the form of issued statistical reports.

Figure 4

A Small Segment of the
Geographic Map

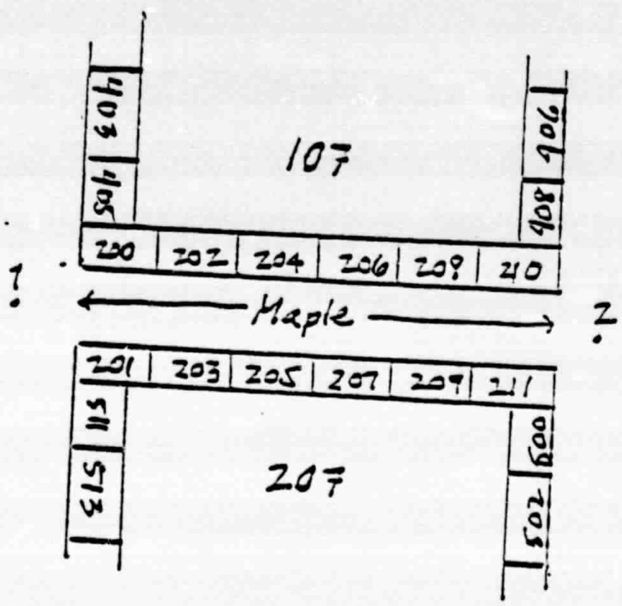
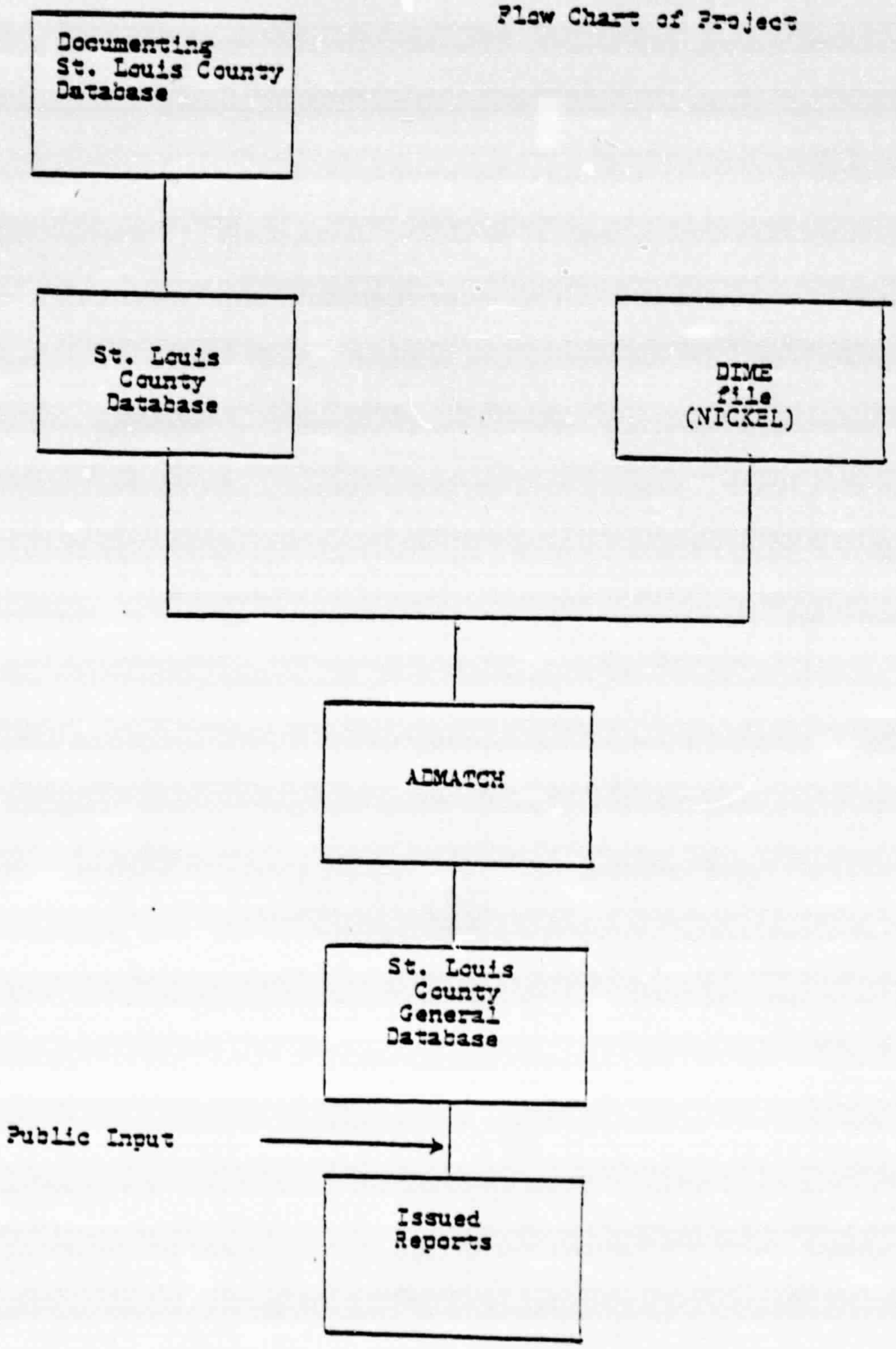


Figure 5
Flow Chart of Project



E. ANALYSIS OF PUBLIC INPUT

In total, out of 93 requests made to fill out the questionnaire, 30 were accepted and completed. 63 were rejected to give a response rate of 32.2%. The responses were classified in two categories of municipal official and real estate/marketing. There were 13 responses in the real estate/marketing and 16 responses in municipal official. There was also one response by an academician at the User's Conference, giving an overall response of thirty. The results are broken up into groupings of questions all pertaining to similar topics. These groupings are presented in a series of four tables each to be discussed in detail. Analysis of the results should be prefaced with the following remarks. On the yes and no type questions, the combined response totals one hundred percent, but on the multiple choice answers, the percentages represent the number that chose that response out of the number of people who took part in the survey. Therefore, for multiple choice type questions, the responses are not expected to total one-hundred percent. Also, the percentage of response for each category is based on the number of responses for that category only and the overall percentages are based on the total number of responses. Analysis of the responses for each table will be given below.

Table 1

The rationale for both these questions was curiosity of the public awareness of the DIME file and its associated features. The first question asked if the responder had ever made use of a DIME file and second asked for which application of the DIME file the responder could have use for. The results showed that those in the real estate/ marketing area have never had contact with the DIME file and only 30% had a use for geocoding using address directories. Of the municipal officials, approximately one third had ever made use of the DIME file, but 62% felt that they had need of geocoding using address directories. The responses to these questions indicate that the responders were not well acquainted with the DIME files which may have hampered their understanding of the capabilities of the project.

Table 2

The questions in this table all deal with the type and format of information that could be available to the public through the project. The choices presented in the question are those that resulted from documentation of the County Data Base.

The first question on this table is very important as it is here that the contents of the report is determined. The high overall response to each of the choices indicates

Table 1

Response to Questions Concerning Awareness of DIME file and Associated Applications

Question	Responses		
	Real Estate/ Marketing	Community Officials	Total
Ever used a DIME file?			
Yes:	0% (0)	31% (5)	17% (5)
No:	100% (13)	69% (11)	83% (25)
Useful Applications of the DIME File			
Geocoding with ADMATCH:	0% (0)	19% (3)	10% (3)
Geocoding with Address Directories:	31% (4)	62% (10)	50% (15)

Table 2

Response to Questions Concerning Type and Format of Information Desired

Question	Responses		
	Real Estate/ Marketing	Community Officials	Totals
Potential Applications:			
a. population estimates:	54% (7)	81% (13)	70% (21)
b. land use estimates:	69% (9)	56% (9)	60% (18)
c. average-age structure:	62% (8)	69% (11)	67% (20)
d. % owner occupied housing:	54% (7)	88% (14)	70% (21)
Preferred Geographic Level of Data Aggregation:			
a. census tract:	15% (2)	31% (5)	27% (8)
b. census block group:	0% (0)	31% (5)	17% (5)
c. census block:	0% (0)	44% (7)	27% (8)
d. municipality:	69% (9)	94% (15)	80% (24)
e. school district:	38% (5)	38% (6)	40% (12)
f. zip code:	46% (6)	6% (1)	27% (8)
g. entire county:	31% (4)	12% (2)	20% (6)
Interest in Time Trend Data			
Yes:	77% (10)	100% (16)	90% (27)
No:	23% (3)	0% (0)	10% (3)
Desire for Time Trend Data Presented on Histograms or graphs:	80% (8)	81% (13)	81% (22)

that both categories would like to see this type of data, but each not to the same degree. Interesting differences are noted concerning the first and the fourth choices of population estimates and owner occupied housing. In both these choices, the municipal official category showed a much greater interest in this type of data. It was suspected that municipal officials would want to see population estimates, and the high interest in owner occupied housing supported the observations of Jim Lehey and Mark Tranel.

The next question concerns the geographic level of aggregation that would be preferred by the public. The geographic unit that had the greatest appeal by far was the municipality. Municipal officials also showed interest in census block data, but not to the same degree. Both categories have a mild interest in data aggregated by school districts. All other geographic units had luke warm appeal, except zip code which was attractive to the real estate/marketing category. This is explained as much of the marketing analysis done by real estate/marketing firms is through zip code classifications.

Another choice not shown on the table is the other-please specify. In this area the requested aggregation that appeared most often (3 times) was for neighborhoods

as defined by the municipality. This indicates a need for data that are specific for a particular small geographic region.

The next question on the table concerns time trend data. Since the initial stages of the project, it was felt by those involved with the project that there was a need for time trend data. This assumption was borne out in the responses to this question. Ninety percent of those who answered indicated they would like to see time trend data. By categories, 100% of the municipal officials want time trend data and 77% of the real estate/marketing category have an interest.

The next question concerning presentation of time trend data, was only responded to by those that have answered 'yes' to the previous question. Therefore, the percentage of responses in this question is based only on those who had given a 'yes' answer to the previous question. For Real Estate/Marketing there were 10 'yes' responses in the previous question, 16 'yes' for Community Officials and 27 overall 'yes' responses.

Those that responded to the previous question, indicating a desire to see time trend data, were asked if they would like to see these data depicted on histograms or graphs. 81.5% of those that answered yes to the previous question also wanted to see histograms and graphs of the data. It

is possible to offer these graphs, as the software package which will perform the aggregation has the capability to make these type of graphs.

Table 3

It has been the intention of the project since the beginning to issue statistical reports, presenting the data from the General Data Base, on a regular basis. The questions in this grouping all deal with the format and frequency which would be desired from the issued reports.

In the first question, dealing with the preferred format for report output, the overwhelming choice was for computer printouts. Typically, municipality do not have the facilities or the staff expertise to make the other alternatives of microfiche and tapes or cards viable.

The next question, asked if the responder would be interested in seeing data from the General Data Base presented on computer generated shaded maps, and if so, at what geographic level would they like to see the data. Figure 9 is an example of a computer generated map for New Haven, Connecticut. The UMSL Computer Center will have the capability to produce these types of maps. The strongest response to this question was to have maps of the data at the municipal level. A stronger desire was shown on the part of municipal officials for maps at this level. Zip code was the preferred choice by real estate/ marketing personnel.

Figure 9

A Computer Generated Shaded Map

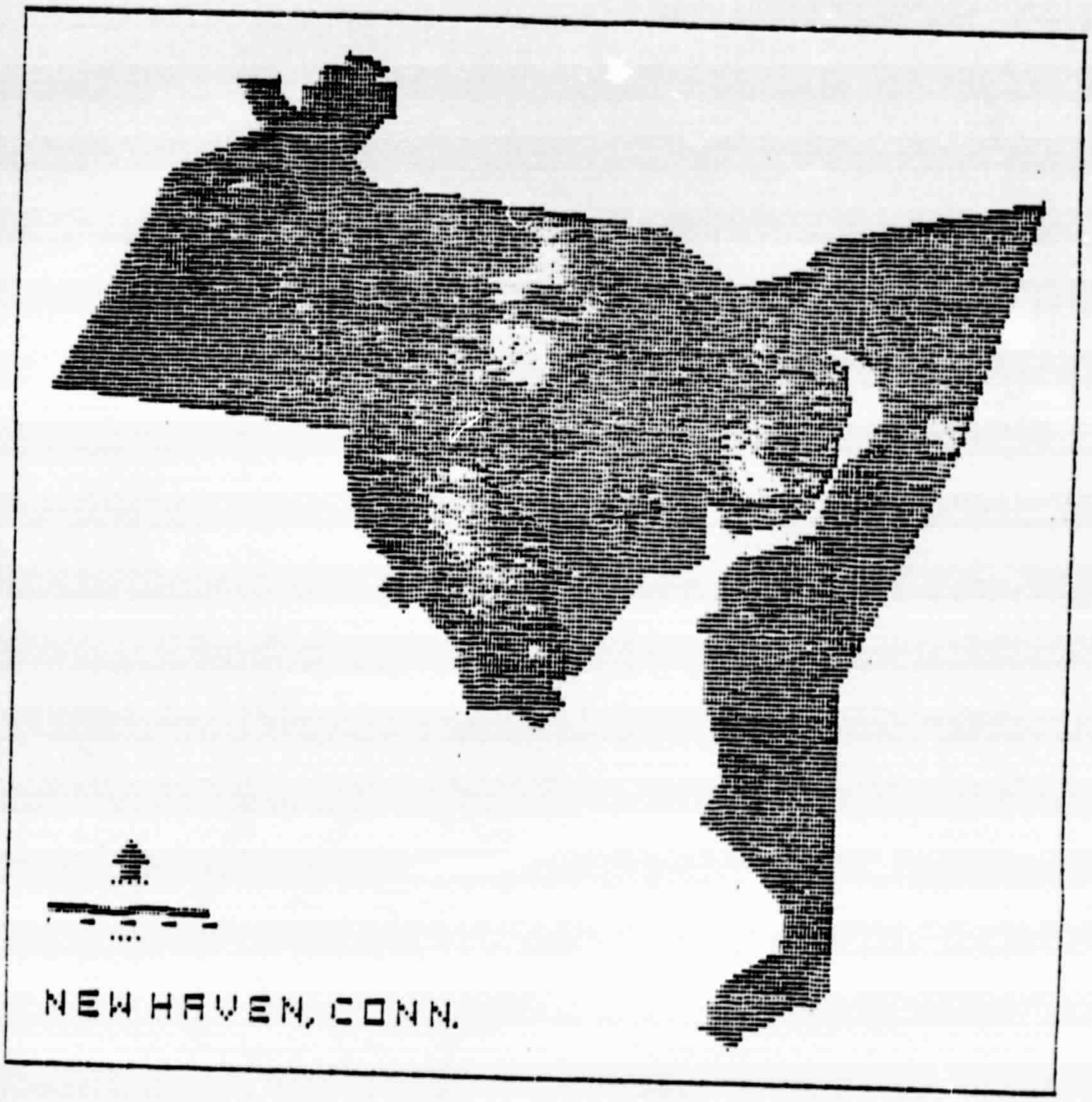


Table 3

Response to Questions Concerning
Format and Frequency of Issued Reports

Question	Responses		
	Real Estate/ Marketing	Community Officials	Totals
Preferred report format:			
a. computer print-out:	92% (5)	100% (16)	93% (28)
b. microfiche:	0% (0)	6% (1)	3% (1)
c. computer files on tape or cards:	23% (3)	0% (0)	13% (4)
Preferred geographic level for computer generated maps:			
a. tracts:	8% (1)	44% (7)	30% (9)
b. municipalities:	31% (4)	88% (14)	60% (18)
c. zip code:	46% (6)	19% (3)	30% (9)
d. census block group:	0% (0)	44% (7)	23% (7)
Preferred frequency of issuing the reports:			
a. quarterly:	38% (5)	31% (5)	33% (10)
b. every 6 months:	23% (3)	25% (4)	27% (8)
c. once a year:	31% (4)	69% (11)	50% (15)

In the last question, half the people responding to this survey indicated that they would like to see the reports issued once a year. By categories, municipal officials showed an even stronger preference to see the data once a year. For real estate/marketing, there is not a concensus of how often reports should be issued; however, reports issued on a quarterly basis was given a slight preference over the other frequencies. Even though there is not overwhelming support for any of the frequencies suggested, it would appear that yearly reports would be an acceptable frequency.

Table 4

The last grouping of questions are those that concern the method of payment for the issued reports, and also gauging interest in attending a seminar that has been proposed to take place in the future. Disucssion of the results of the first question, concerning payment for the issued reports, would not be of relevance without an of the rationale behind the question.

The merging of the databases requires a great deal of computer time and this presents a cost that must be paid for. Once the general database file is created, the costs of producing each report is very small compared to the large overhead cost of merging the databases. It was

Table 4

Response to Questions Concerning
Willingness to Pay for Reports and Desire
to Attend a Seminar on Project

Question	Responses		
	Real Estate/ Marketing	Community Officials	Totals
Interest in subscription method of payment:			
Yes:	77% (10)	75% (12)	77% (23)
No:	23% (3)	0% (0)	10% (3)
Maybe:	0% (0)	25% (4)	13% (4)
Interest in attending a seminar:			
Yes:	46% (6)	75% (12)	63% (19)
No:	54% (7)	19% (3)	33% (10)
Maybe:	0% (0)	6% (1)	3% (1)

realized, at the initial stages of the project, that somehow funding must be made available to pay for the computer time. This funding had to be reliable and large enough to cover the costs. Several schemes were suggested and they included: providing the reports free and payment made through a grant or funding from the County, make a charge based on each request, or devise a subscription system. The first two schemes were rejected as either funding was not realiable or that there was no guarantee the overhead would be covered if too few requests were made.

The only method that appeared to solve the problem of reliability was the subscription system. Using this system, it would be known before the actual merging process, how much money was available and how many reports needed to be generated. As stated in the question, it is not known what the fee will be or how often the report will be issued. This question was purposely written to only suggest the subscription system as this was the only method of payment that was deemed acceptable for payment. The answers to this question would indicate if the public was willing to pay for the information and if the subscription system was a suitable method of payment.

The replies to this question were unique in that even though the question was intended to be answered yes or no, a maybe response was sometimes given. This maybe response

would take the form of a tentative yes, but with qualifications such as: it depends how the data are aggregated or how much the data will cost. There were only four responses of this nature and they were from municipal officials. In both categories, 76% of those responding favored the subscription system of payment. There was a no response by 23% in the real estate/marketing category, and 0% no response by municipal officials. It is encouraging that the intended target group of municipal officials were willing to pay for the data.

The next question within the table asked if the responder would be interested in attending a seminar in which the project would be discussed in greater detail. Interest in attending such a seminar was solid, but not overwhelming. Municipal officials were much more willing to attend the seminar than real estate/marketing people, indicating that municipal officials have a stronger desire to have this type of data available. The response by real estate/marketing was indicative of my observations over the telephone with these people which is that they have done without this type of data for a long time, and they are in no hurry to get it, but if it were available, they wouldn't mind having it.